

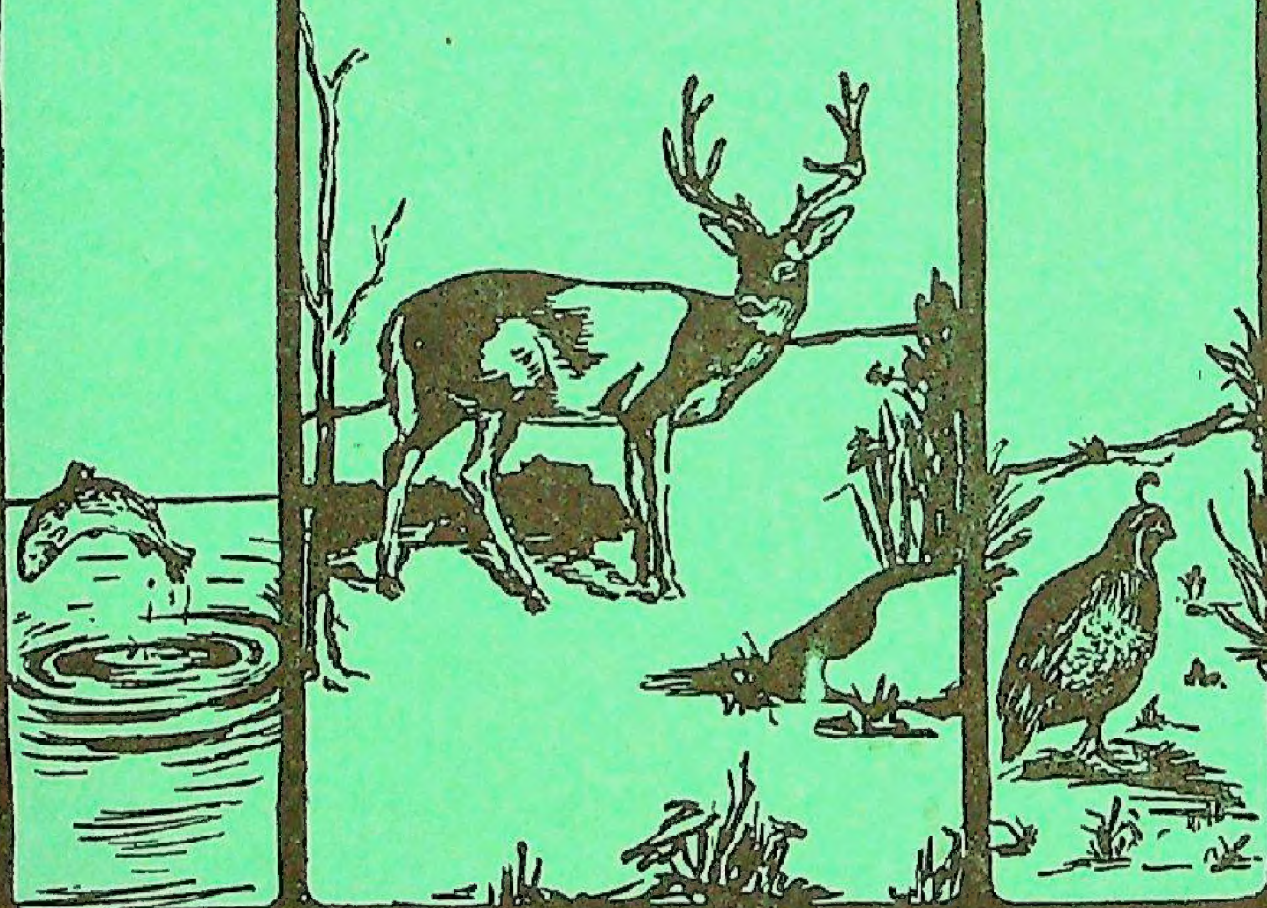
CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 26

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Number 2



STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND GAME
San Francisco, California

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TABLE OF CONTENTS

	Page
The Trouts of California----- <i>John O. Snyder</i>	96
The Deer of California, with Particular Reference to the Rocky Mountain Mule Deer----- <i>Donald D. McLean</i>	139
A Report of Predatory Animal Control Activities for the Year Ending June 30, 1939----- <i>Gordon H. True, Jr.</i>	167
Dr. Joseph Grinnell, February 27, 1877-May 29, 1939----- <i>Donald D. McLean</i>	175
Editorials and Notes	
Twenty-five Years Ago In "California Fish and Game"----- <i>Richard S. Croker</i>	178
Results of the 1939 Pismo Clam Census----- <i>Phil M. Roedel</i>	178
A Spiny Lobster (<i>Panulirus interruptus</i>) Recovered in Monterey Bay----- <i>J. B. Phillips</i>	179
A True Smelt Found Near Los Angeles Harbor----- <i>Frances N. Clark</i>	180
Reviews	
North Pacific Fisheries, with Special Reference to Alaska Salmon----- <i>Richard S. Croker</i>	181
Veiled Horizons; Stories of Big Game Fish of the Sea----- <i>Richard S. Croker</i>	182
In Memoriam	
Captain William Lippincott----- <i>E. L. Macaulay</i>	183
Reports -----	185

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THE TROUTS OF CALIFORNIA¹

By JOHN O. SNYDER

Anglers and naturalists from long before the time of Walton or Artedi have talked and written about the trouts. They have set them apart from among the fishes because of their beauty of form and color,

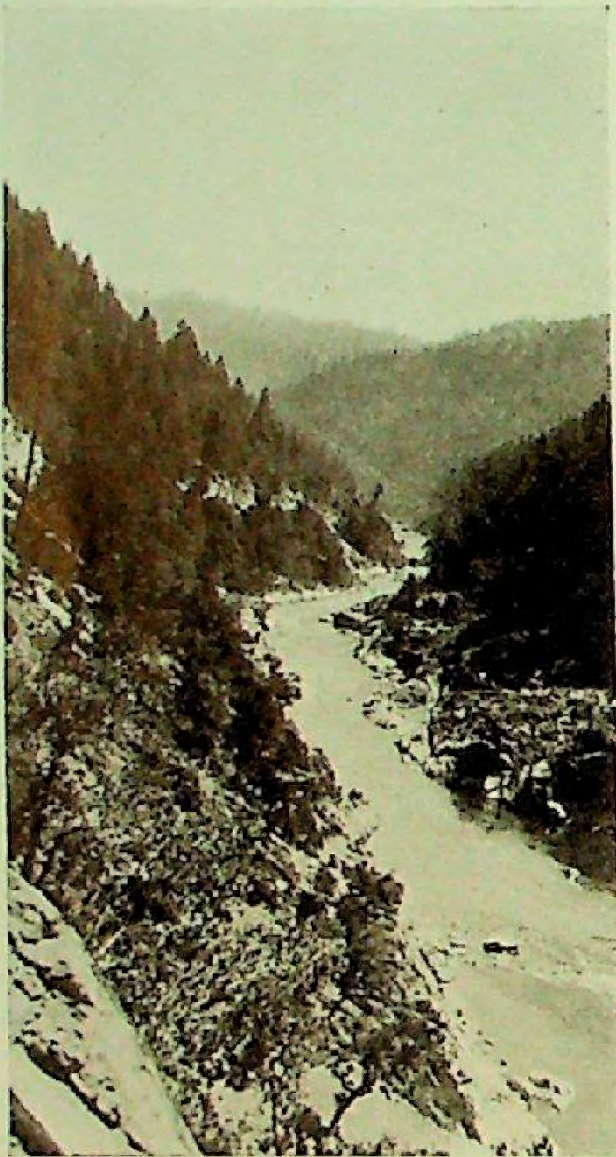


FIG. 27. Klamath River near the mouth of Clear Creek. A turbulent mountain stream.

their shy and wary disposition, their tremendous energy and fighting spirit, their delicious food qualities, and above all their association with the placid pools of the valley streams and the sparkling, turbulent waters of the forested hills and snowy peaks. To the more thoughtful comes an appeal to muse on the apparent vagaries of nature which allow these fish to dress in modest browns and olives in boggy waters, in silvers and blues in mountain lakes, or in a veritable riot of scarlet and gold in the plunging streams of the mountain slopes. The naturalists in particular have indulged in long and learned dissertations on the speciation of trout, their nomenclature, geographic distribution, propagation and what not. The subject of trout and trout fishing is still a live one in many quarters.

It is the purpose of this paper to present an account of the trouts of California in a somewhat sketchy fashion, avoiding tiresome scientific details, and at the same time keeping as near the prosaic truth as may be expected when the season is open and rods, lines and lures are within easy reach.

DISTRIBUTION AND RELATIONSHIPS

The trouts are all more or less boreal fishes, and where they have succeeded in extending their distribution over any considerable area in the direction of the tropics they have taken advantage of alpine, i.e., high mountain conditions. The most southerly American species

¹ Submitted for publication, February, 1940. This paper is a revision of "California trout," by the same author, which appeared in CALIFORNIA FISH AND GAME, vol. 19, pp. 81-112, 1933.

is the rainbow trout of the San Pedro Martir Mountains of Lower California, where a relatively few individuals representing an isolated species exist in a precarious situation. They are the last survivors of a time, when through more favorable climatic conditions trout were abundant in the southern coastal region where they are now rare or entirely extinct. Their presence calls attention to a period in the remote past when steelheads from the sea entered streams far south of our borders and spawned in the mountain tributaries. The San Pedro Martir trout are now permanently cut off from the ocean, being unable to accomplish a safe passage through the sub-tropical lower course of the stream in which they live. Somewhat similar cases, but with less complete isolation, are furnished by the native trout of the San Bernardino Mountains and the Piute trout of Fish Valley. Trout in situations such as these are isolated much as are humans on oceanic islands. There is no way to escape or spread, neither is there an opportunity under natural conditions for contamination of the breed or strain by



FIG. 28. Butte Creek, a quiet valley stream.

blood from the outside. Under such circumstances, forms whether fish or human beings, tend to differentiate and assume peculiarities which ultimately serve to distinguish them, and they come to be known to us as distinct species or races. For convenience we give them names, scientific or common.

Although boreal in their habitat and fluvial in derivation, trout have come to adapt themselves to life in the ocean, being anadromous where conditions permit. They also have invaded the lakes and accommodated themselves to considerable depths. However, they have not in any case entirely broken away from their ancient fluvial heritage in that cool, rapid, and well aerated water is necessary for their early life.

The trouts belong to a great and ancient family, the Salmonidae, fishes that have not attained a high degree of anatomical specialization. Their general structure and external appearance are simply fish-like. They bear no special armor such as plates or spines, no particular or peculiar fin structures, no dermal tentacles, barbels or fantastic orna-

ments. The Salmonidae occupy a position in the zoological classification of fishes somewhat midway between the sharks with their simple and primitive skeletons of cartilage, and the higher fishes as the basses or cods, which possess a bony framework of great complexity. The trout, none the less, have specialized in one particular, that of bodily color, in which some of them rival the most brilliant productions of the tropical seas.

The Salmonidae are represented in the waters of California as follows:

Native Species

Salmon, *Oncorhynchus*; four species—King, Silver, Humpback and Dog. The king and silver are of commercial and sporting importance. The others are scarcely ever seen.

Trout, *Salmo*; many species.

Charr, *Salvelinus*; one species.

Whitefish, *Prosopium (Coregonus)*; Truckee River and Lake Tahoe basins.

Introduced Species

Trout and Atlantic Salmon, *Salmo*; several species.

Great Lakes Trout, *Cristivomer*.

Brook Trout, *Salvelinus*.

Montana Grayling, *Thymallus*.

NATIVE TROUTS

The difficulty of separating and defining the various species or races of western trout has long been recognized. The problem does not essentially differ, however, from that presented by the chipmunks or song sparrows, or even the native aborigines. In their entirety they seem to form a huge mosaic, the elements of which, as diverse as the golden trout of the High Sierra, the coast rainbow and the royal silver trout of Lake Tahoe, are difficult to separate. The picture includes not only the colors of the entire spectrum, but numerous irregularities of form, anatomical structure and habits as well. These trout present a veritable medley of geographic races or forms that make logical treatment very difficult. Attempts at systematic investigation have been made and some generally accepted species have been recognized. These attempts have been sporadic in all cases; they have been founded upon insufficient material, and they have not contributed greatly to a reasonable interpretation of the situation as a whole. The problem may now be impossible of satisfactory treatment because of depletion or near extermination of certain forms of restricted distribution and of the activities of artificial propagation in the distribution of various trouts.

Real contributions to the speciation of trout will not come from cursory inspections of occasional fish from here or there, but rather from careful and coordinated studies of large series of examples from single localities.

California trout, as also the stories relating to them, sometimes grow to enormous size. There are many records of over 20 pounds for both rainbows and cut-throats. Commercial fishermen once took 14,578 steelheads in Klamath River from August 5 to September 6. On some

days these fish, large and small, averaged as little as 3.2 pounds or as large as 6.7 pounds. The average weight of the entire number was 5.7 pounds. In the winter migration the fish are much larger, examples frequently weighing 12 to 28 pounds according to sober and competent observers.

It takes several years for a trout to attain a weight of 5 or 6 pounds, longer than for a deer to reach a legal size for the hunter. Yet the present legal day limit on trout carries less restriction than the year limit on deer and the open season on trout is very much longer. Unless precautions are soon taken it seems evident that some of our native trouts like our wild flowers will disappear, giving place to various exotic weeds and mongrel crosses.

The following species of native trout have been generally recognized:

Rainbow Series, pages 123-130

Coast Rainbow Trout, *Salmo irideus*. All streams entering the ocean.

Shasta Trout, *Salmo stonei*. Upper Sacramento and McCloud rivers. The rainbow trout of fish culture fame.

Kern River Trout, *Salmo gilberti*. Kern River and possibly other streams draining the southern Sierras.

Soda Creek Golden Trout, *Salmo whitei*. Upper Kern tributaries, Soda Creek, Wet Meadow Creek, Coyote Creek and Little Kern River.

South Fork Golden Trout, *Salmo aqua-bonita*. South Fork of Kern River, Volcano Creek.

Culver Lake Trout, *Salmo rosei*. Lake Culver and neighboring lakes of the High Sierras.

San Geronimo Trout, *Salmo evermanni*. San Bernardino Mountains.

Eagle Lake Trout, *Salmo aquilarum*. Eagle Lake.

Royal Silver Trout, *Salmo regalis*. Lake Tahoe.

Cut-throat Series, pages 130-135

Coast Cut-throat Trout, *Salmo clarki*. Coastal streams south to Mad River.

Tahoe Cut-throat Trout, *Salmo henshawi*. Lake Tahoe and Truckee basin, Walker, Carson and Owens rivers.

Piute Trout, *Salmo seleniris*, a geographic variant of *S. henshawi*. Fish Valley, Alpine County.

Colorado River Trout, *Salmo pleuriticus*. Salton Sea, New River.

The Charrs, pages 136-137

Dolly Varden Trout, *Salvelinus spectabilis*. Upper tributaries of Sacramento River.

The localities given are original ranges; fish-culturists have extended the ranges of many species to a great extent.

INTRODUCED SPECIES

A considerable number of exotic fishes have been introduced into the State. Some of these appear to occupy niches not so well adapted

to native species where they thrive and furnish sport fishing. Others are of questioned value and some are recognized nuisances.

The distribution of introduced species should be guarded with great care and so controlled as not to displace or endanger the native trout. The introduction of foreign animals is usually attended with danger and sometimes with disastrous results. Its practice usually comes from a too prevalent human desire to tinker and meddle with nature. In many cases it accompanies an inability or an unwillingness to conserve native fishes which in some instances are markedly superior.

Introduced trout and trout-like forms are (see pages 136-138):

Loch Leven Trout, *Salmo levenensis*, early crossed with importations of Brown Trout, *Salmo farió*, of Europe.

Brook Trout, *Salvelinus fontinalis*, a charr, native of Atlantic coast streams.

Mackinaw Trout, *Cristivomer namaycush*, from the lakes of north-eastern United States.

Montana Grayling, *Thymallus montanus*, which now appears to be established in the Yosemite region. When compared with trout the grayling is immediately distinguished by its large and highly colored dorsal fin. The mouth is smaller and the body more slender. The eggs are more delicate than those of trout. The grayling is a gamy fish and not so wary as the trout. It is sub-arctic in distribution, adapted only to our high mountain waters.

Atlantic Salmon, *Salmo sebago*. Attempts have been made from time to time to introduce this fish but without apparent success. Lately large introductions were made in Smith River. This species will not, as popularly supposed, replace western salmon, *Oncorhynchus*, where they have become depleted but will, if established, be a competitor of our native steelhead.

THE CUT-THROATS AND THE RAINBOWS

In the opinion of the writer, all of the native trouts of California (excepting the charrs) belong to two groups or great races, namely the cut-throats and the rainbows. The cut-throats are the more boreal or alpine, while the rainbows are the more austral, and more generally distributed. The cut-throats are characterized by having smaller scales, a somewhat more complete dentition, more numerous black spots, and usually a red streak beneath the mandible, from the presence of which their name is derived.

The cut-throat is found in the coastal streams from the Oregon border southward to Redwood Creek, or possibly Mad River. It has been reported from Eel River, but no examples have come to hand in support of the record. It occurs in the eastern drainage of the Sierras (Truckee, Carson, and Walker basins, and in Owens River), and in the Colorado River from which it gained a temporary access to Salton Sea.

The rainbows are pretty generally distributed in the trout waters of the State, in some places living as natives with the cut-throats. Rainbows inhabiting the upper courses of the mountain streams have finer scales than those of the coastal region, thus exhibiting a well known boreal characteristic.

By adherence to the assumption that all California trouts may be assembled in two natural groups, cut-throats and rainbows, one is enabled to account for their derivation and relationships as well as their present geographic distribution in a fairly logical way.

THE STEELHEADS

Some observers hold to the belief that the steelhead is a distinct species of trout somewhat intermediate between the cut-throat and the rainbow. Such is not the case, and this statement is supported by a mass of observational and experimental evidence. A steelhead is a sea migrant of the particular species inhabiting the stream, and in our waters it may be either a cut-throat steelhead or a rainbow steelhead, and there is no occasion to apply a Linnean binomial name to a steelhead as such.

The steelhead is a fish that has come from the sea and entered a river to spawn. The resulting young live in the stream for from one to three years as rainbow or cut-throat trout and then migrate to the

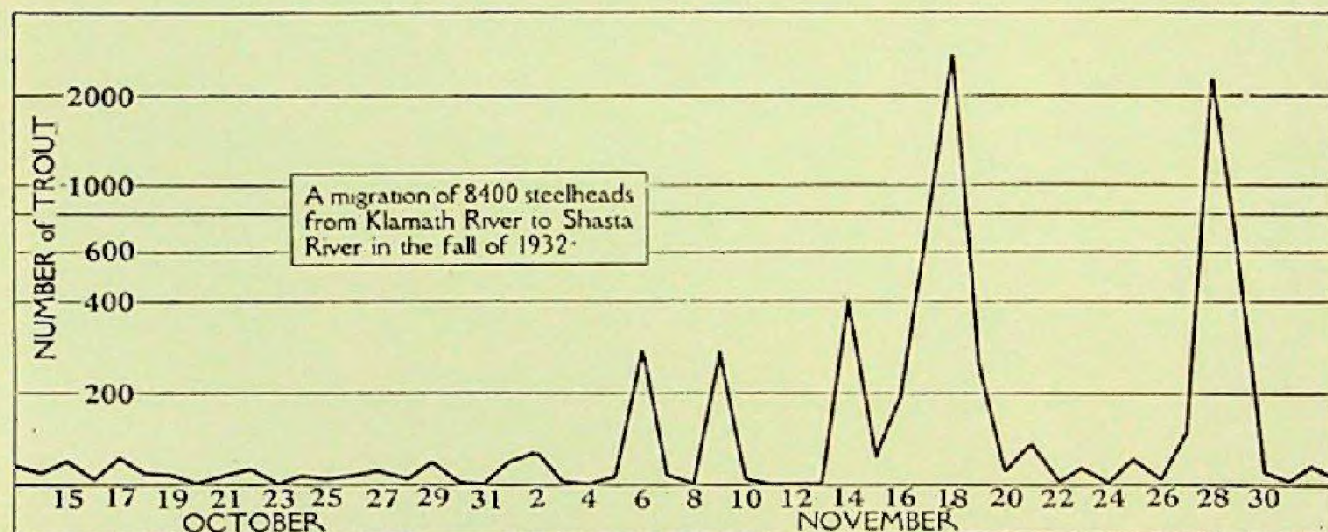


FIG. 29.

ocean. Some individuals appear to remain in fresh water during life. Steelheads come in from the sea in regular migrations which occur at more or less definite times. The migration is so timed as to provide for the arrival of the fish on the spawning beds when conditions are best fitted for propagation. For example, a migration of such fish appears in the estuary of Klamath River during the fall and early winter. The fish of this migration have in general a long distance to travel. Their entry into the river and their progress up stream are apparently coordinated with conditions in the tributaries. They enter Shasta River where their migration is in full swing, long before they appear in Beaver Creek, the mouth of which these advance migrants have already passed. The smaller coastal streams are not visited so early, some of them being temporarily closed by bars, while others although open do not have a sufficient flow of water. A migration is not a steady movement of fish. It has a general rise and decline, but it has periodic irregularities as well, waves of varying intensity so as speak, the cause of which is problematical.

In the larger streams which are permanently open to the sea the migrations occur at about the same time each year. In Klamath River,

for example, steelheads appear in the estuary in numbers about July 15. From then on they progress up the stream, appearing at various points about as follows: Klamath Glen, August 1; Weitchpec, August 8; Bluff Creek, August 12; Orleans, August 20; Somes Bar, August 24; Clear Creek, September 3; Happy Camp, September 7; Seiad Valley, September 16; Scott River, September 20; Oak Bar, September 25; Brown's, September 29; Shasta River, October 3; Klamathon, October 8; Fall Creek, October 20. (See Fig. 31.)

As the steelheads appear fresh from the ocean they are a beautiful steel blue above with bright, silvery sides. They usually have very definite black spots on the head and body (those of the head round, of the body linear), and on the unpaired fins. Sometimes the head is without apparent spots and the body has relatively few. The ova found in the early migrants are very small, their relatively undeveloped condition giving rise to the conjecture that these fish have entered upon a



FIG. 30. The mouth of Klamath River where the steelheads come in from the sea. This photograph was taken before the construction of the jetty.

very long migration, or at least a considerable sojourn in fresh water, and this has been found to be true. Later migrants usually have more mature ova, as their spawning time is less remote.

On entering the streams their stomachs are usually empty, and they seem to remain so while they are in the estuaries. A little farther up stream their appetites appear to return, and their behavior is governed accordingly. They snap a fly or a spoon with avidity, and in rapid water they severely test the angler's skill. It appears, however, that the activities of stream life are largely supported by stored energy which has been accumulated in the sea. They enter the stream robust and corpulent, overloaded with vigor, and they leave relatively wan and emaciated.

Steelheads enter all the coastal streams which are large enough, sometimes appearing where the volume of water is scarcely sufficient to carry them. When fresh from the sea, resplendent in their blues and bright silver, the steelheads may often be seen in numbers leaping

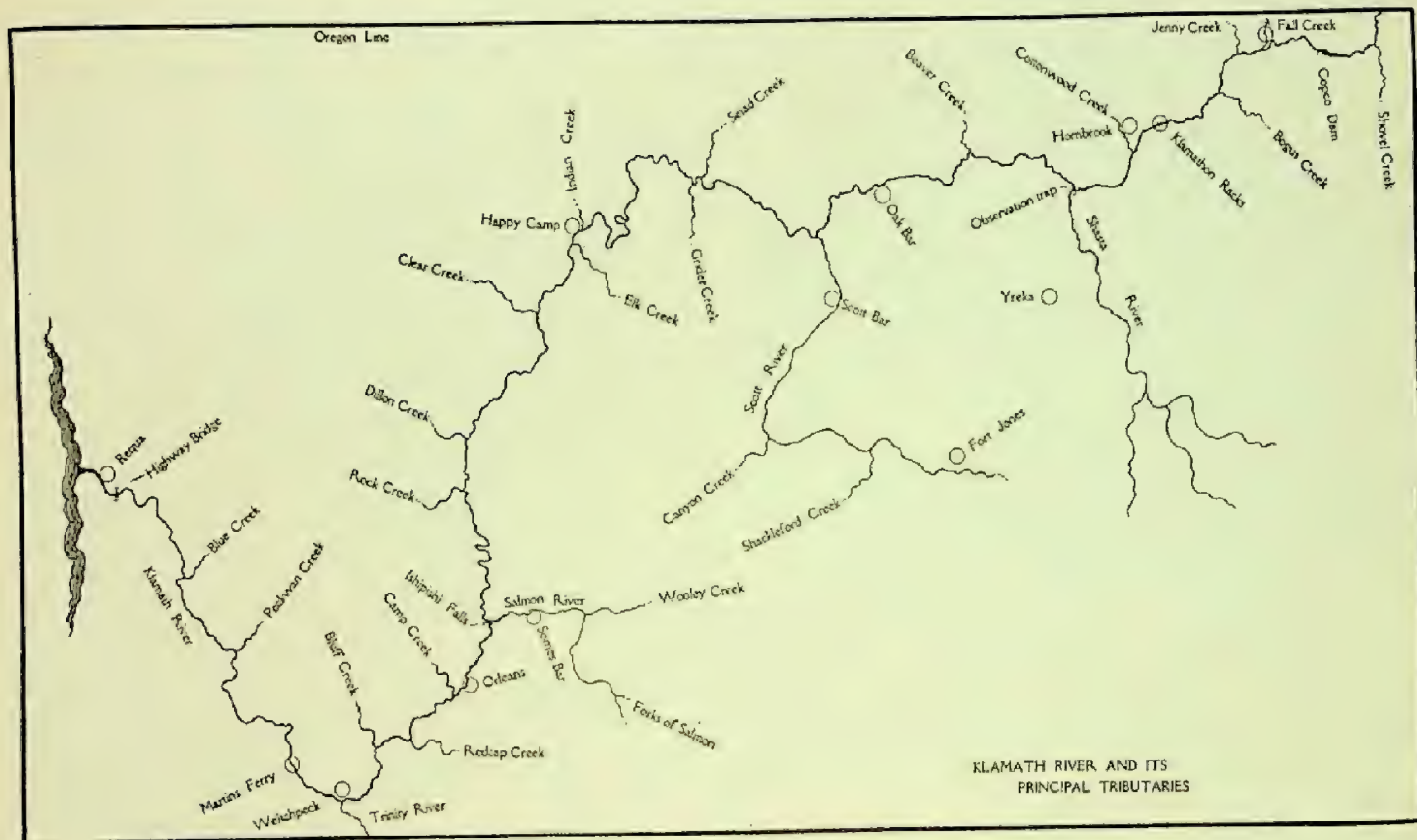


FIG. 31.

high from the surface of the water and falling with a great splash. They seem fairly intoxicated from their new experience in the stream. Soon their colors begin to change. Their linear spots grow larger and more nearly round while others appear in regions where they seemed absent. As time passes and they progress up stream they assume the bright hues of stream trout, and all degrees of coloration may be found among them from the typical steelhead to that of a brilliant rainbow. Sometimes belated steelheads progress so rapidly as to be found near the headwaters still bearing much of their marine color and mingling with more brightly tinted trout already arrayed in their nuptial hues. Steelheads all come to the fresh water to spawn, and unless prevented most of them will accomplish their purpose and eventually return to the sea. Some die, perhaps from injury, old age, or from the unusual exertion incident to migration. A few remain for an indefinite time in fresh water. In many of the larger streams with constantly open communication with the sea, are trout of considerable size and scarcely if at all distinguishable from the spawning steelheads. These fish appear to be residents of the river.

Lake rainbows behave as do ocean steelheads, migrating from the deep water to spawn in the streams. The cut-throat of Pyramid Lake, Nevada, furnishes an exact parallel with the ocean steelhead in that its lake colors are largely silvery and pale olive, while in the river on its spawning migration it assumes a wonderful dress of red and gold.

The cut-throat steelheads of the coastal streams of the State perform only short migrations up stream, leaving the real mountain climbing to the rainbows.

Steelheads are sometimes caught by fishermen at sea, far from the mouths of any rivers. When so taken they look exactly like fish which have just entered the river.

Steelheads bear a superficial resemblance to salmon, four species of which migrate into our streams to spawn. Salmon all die after spawning and in this they differ greatly from steelheads. There is no occasion to confuse steelheads and salmon if one observes closely. While they differ in many anatomical particulars, the trout, large or small, may be known by the shorter anal fin base (rays usually 12 or fewer, compared with 13 to 16 or more in the salmon), the deeper caudal peduncle (see Fig 32), the narrower anal fin, and the white lining of the mouth. A salmon's mouth has much black inside. The color of the flesh is not of interest in this connection, as an occasional steelhead or trout has very red flesh, while some salmon may be pink or almost white.

The determination of the specific status of the steelhead is an important step in the direction of conservation, for it now becomes evident that protection for the steelhead involves both the rainbow and cut-throat trouts. Overfishing of stream trout depletes the steelhead and destruction of the steelhead removes the breeding stock of the stream trout.

During the summer and fall the steelhead streams which are not greatly depleted are amply stocked with robust and vigorous little fish, the result of natural propagation. These are nicely and equally distributed throughout the well-aerated, food producing tributaries. If these were well protected and allowed to migrate to the sea, a supply

of returning steelheads would be assured. It is the writer's opinion that the introduction of artificially propagated fish in such situations upsets the balance and serves no good purpose. He further believes that ample protection of nursery tributaries, or what amounts to the same, an enforced size limit of eight inches or so, would insure steelhead fishing in the northern coastal streams for many years to come. An enforced size limit would of itself tend to keep anglers away from small tributary streams, in which, as a rule, only young fish occur.

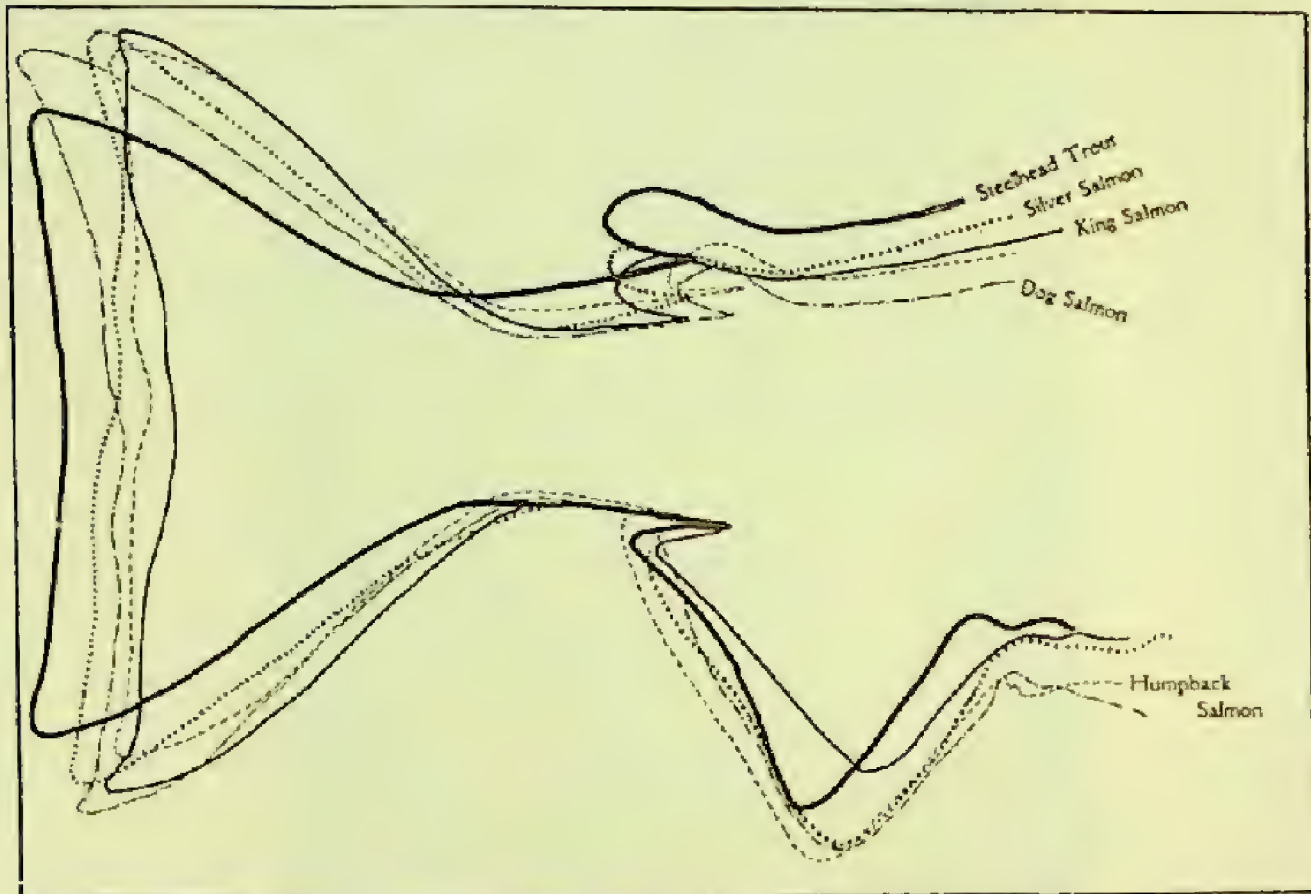


FIG. 32. Tracings of the outlines of the posterior fins and the caudal peduncles of salmon and the steelhead, each of which was of the same length.

THE SCALES OF TROUT

Contrary to the expressed belief of some anglers, all trout have scales. They first appear as little rings or plates when the fish measures an inch or so in length (see Fig. 34) and their size increases nearly in proportion to that of the fish. In some cases, particularly when the trout approaches the spawning period, the skin thickens and the minute pouches which hold the scales tend completely to enclose them, and they seem to disappear.

The scales are very thin, flexible, and are almost perfectly transparent. They grow by the addition of circular plates, and when examined under a lens appear much like the cut end of a small tree limb, in that they present growth rings. They also exhibit annular regions which correspond to the periods of inactive growth. Growth rings are illustrated by figure 33, which was made from a scale of a Waddell Creek trout.² It is enlarged 34 diameters. An area of

²Snyder, Cedric O. A study of the trout (*Salmo irideus* Gibbons) from Waddell Creek, California. CALIFORNIA FISH AND GAME, vol. 24, pp. 354-375, 1938.

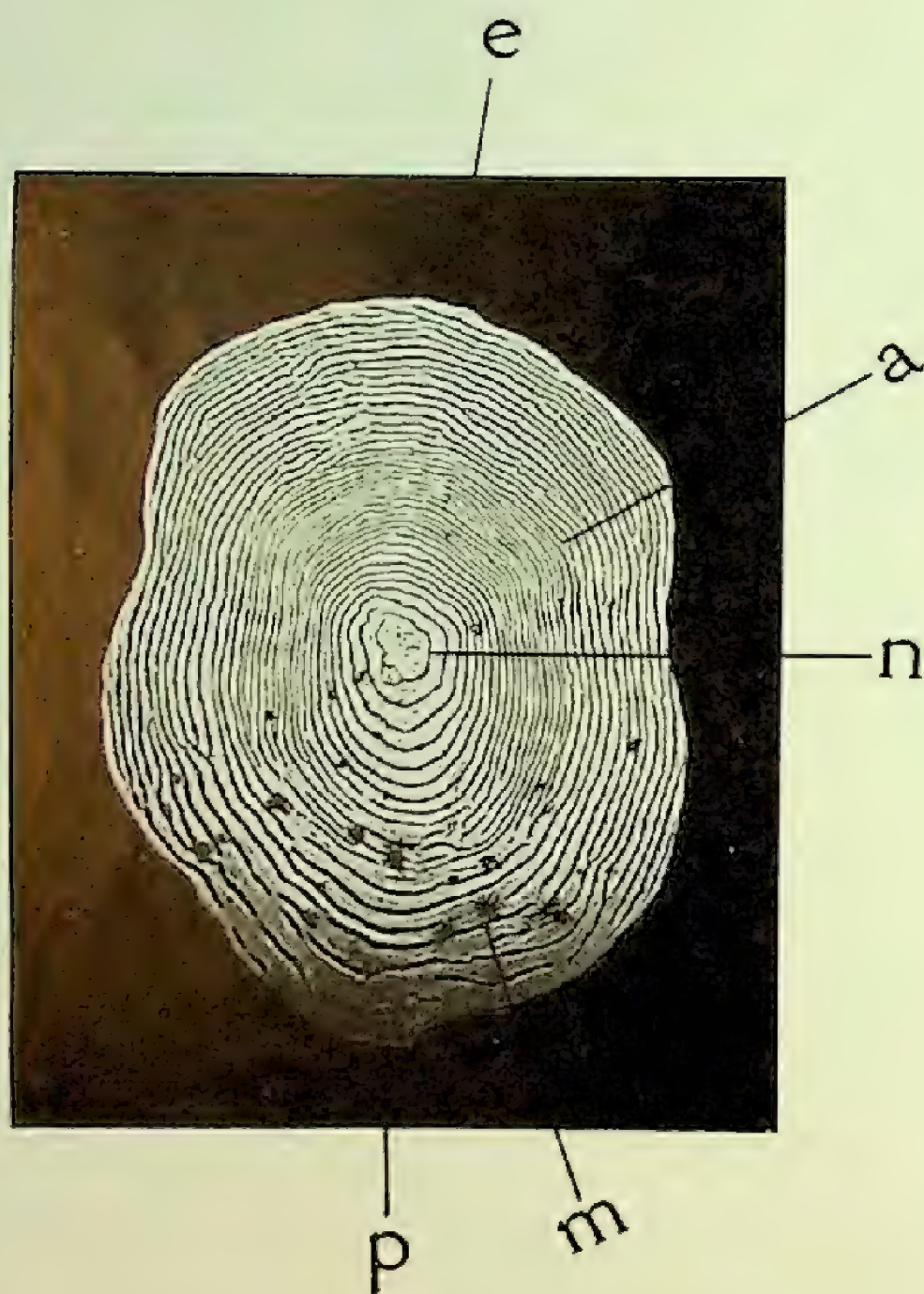
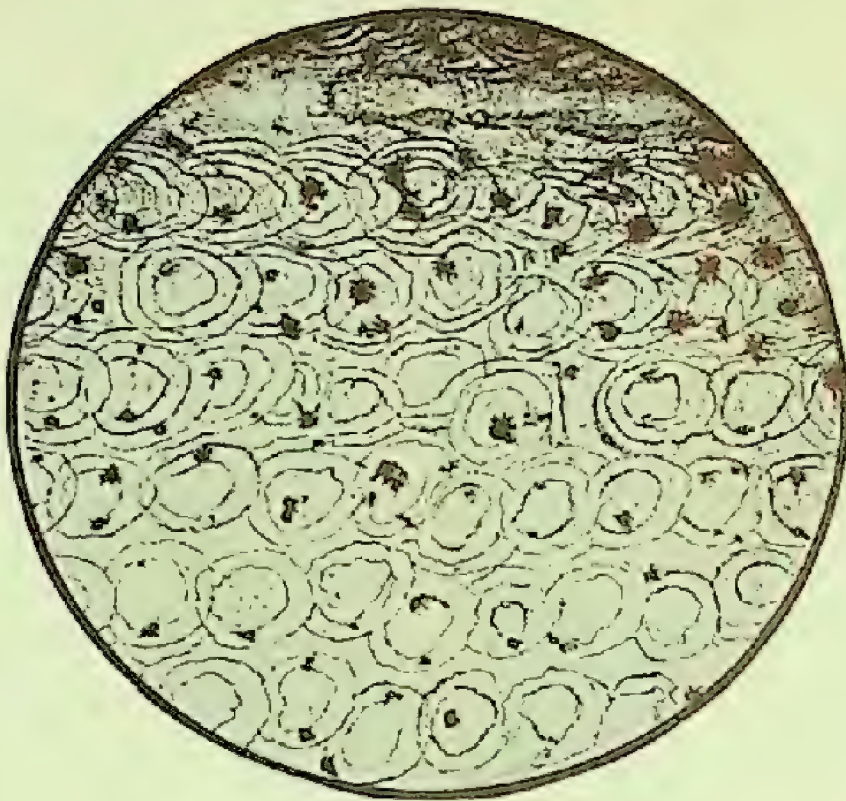
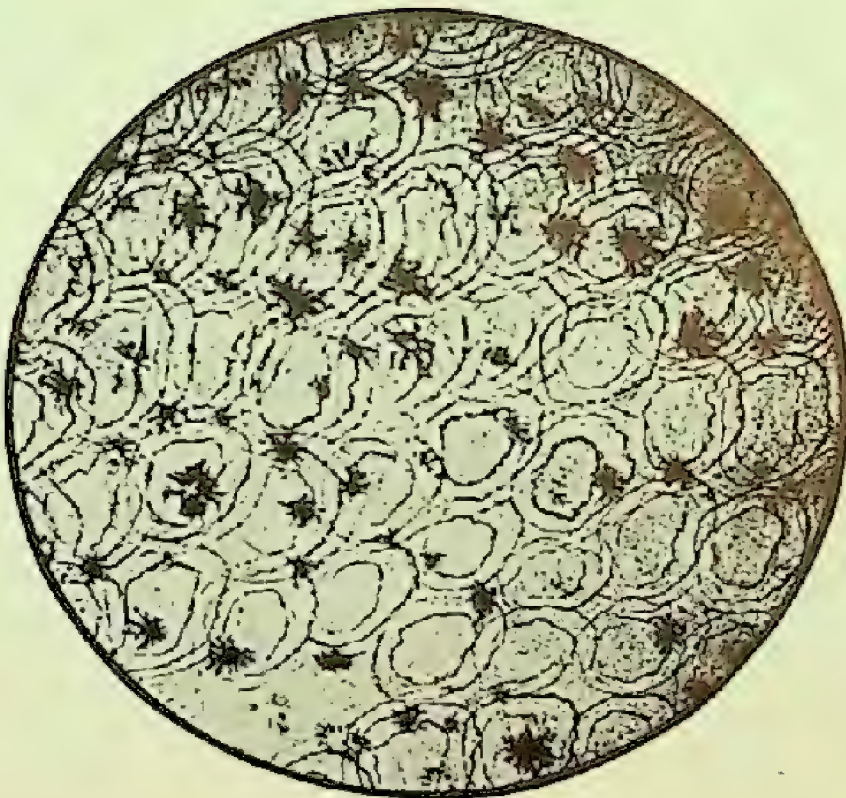


FIG. 33. Trout scale, from fish in its second year, 185 mm., July 7, Waddell Creek, California; *e* is anterior end; *p*, posterior end; *n*, nucleus; *a*, annulus; and *m*, melanophore.



a



b

FIG. 34. Sections of skin with scales adhering, from young trout: *a*, 52 mm., May 28; *b*, 48 mm., June 26. From Waddell Creek, California.

arrested growth is seen at the point *a*. The anterior or forward part of the scale is marked *e*. This part is embedded in the skin. The posterior, exposed part is marked *p*. The central part, *n*, sometimes termed the nucleus, represents the primitive plate, similar to the little scales represented in figure 34, whereas the surrounding dark rings



FIG. 35. Scales from young rainbow trout, Waddell Creek: *a*, 87 mm., July 7; *b*, 97 mm., August 15; *c*, 107 mm., January 21; *d*, 115 mm., February 5.

represent the edges of the plates formed through added growth. It will be noted that the rings follow each other outwardly from the nucleus in fairly regular fashion until the point *a* is reached, where they are somewhat less distinct and more closely crowded. This narrow region is called the annulus, and represents the end of a season's

growth. Beyond this point the rings are wider apart, representing more rapid growth.

If in spring or early summer one examines the scales of the little trout, two inches or so in length, the scales will appear much like those represented in figure 34. Young trout taken later in the

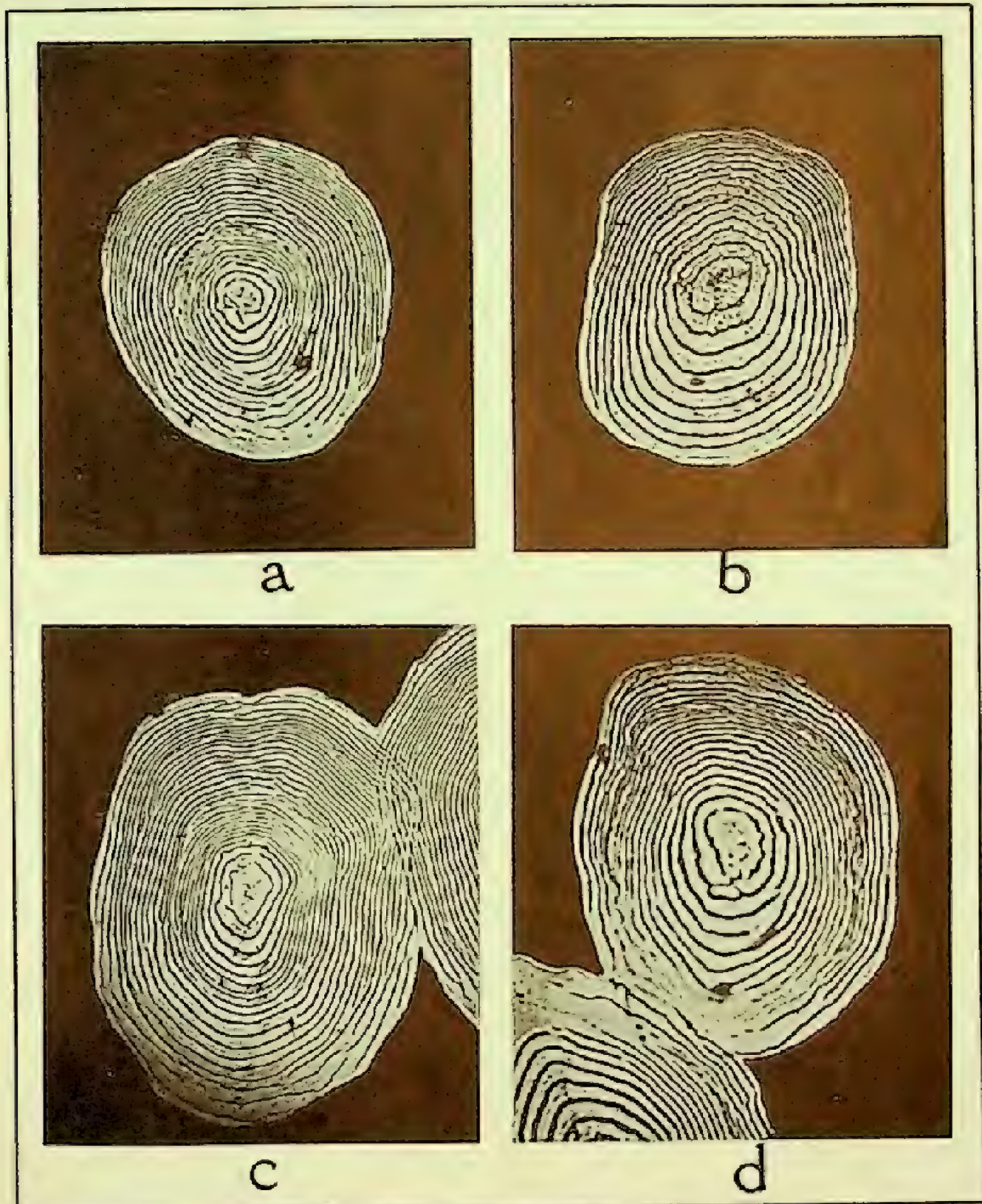


FIG. 36. Trout scales, Waddell Creek: *a*, 139 mm., January 14; *b*, 114 mm., February 5; *c*, 139 mm., February 11; *d*, 138 mm., March 10.

season, and considerably larger in size will have scales like *a* and *b* in figure 35. It will be seen that these differ from the smaller scales only in having additional growth rings. Later in the year an annulus

forms as in *c* and *d* of the same figure. Figure 36 is further instructive. The scale *a* taken from a fish January 14, measuring about $5\frac{1}{2}$ inches, has completed its second season of growth. Both the fish represented by this scale and that by *b* have ceased active growth, whereas *c* and *d* are scales in stages of resumed growth that is very active.

Geographic location, variable seasons, food supply, temperature, and other factors influence growth, and growth in turn is reflected in the anatomy of the scale.

When the small trout enter the sea where food exists in relative abundance, a remarkably rapid growth follows. This is well shown in figure 37 where the area of the scale from the point marked 3 outward represents ocean growth.

The unusual activities attending migration and spawning together with the rapid development of eggs or milt not only arrest bodily growth at the time, but also cause such a heavy draft upon some of the tissues as to partly break them down. This condition becomes a matter of record in the scales, and leaves what is commonly called a spawning scar, visible at A and D in figure 37. This figure represents a fish that had migrated from the stream into the ocean in its third year of growth. It had successfully spawned two times as indicated by the scars, and returned again in its fifth or sixth year. This fish measured $25\frac{1}{2}$ inches and was caught in Klamath River.

An examination of some Klamath steelheads reveals age, growth and spawning records as follows:

<i>Stream</i>	<i>Ocean</i>	<i>Spawmed</i>	<i>Age</i>	<i>Length</i>
1 year	2 years	0 times	3 years	270 mm.
3 years	3 years	2 times	6 years	645 mm.
1 year	4 years	2 times	5 years	625 mm.
2 years	3 years	2 times	5 years	635 mm.
3 years	4 years	3 times	7 years	640 mm.
2 years	2 years	1 time	4 years	480 mm.
3 years	2 years	1 time	5 years	530 mm.
2 years	3 years	1 time	5 years	635 mm.
2 years	2 years	0 times	4 years	370 mm.
3 years	1 year	0 times	4 years	345 mm.

There is here a possibility of learning much of the life of a trout, as we are able to read the more or less accurate record preserved in the scales.

SPECIAL SENSES

There is little doubt that trout possess some of the special senses developed to a considerable degree of perfection. Sight is evident, but the degree of selective vision is in doubt. In inspecting an object on or above the surface the fish is at a disadvantage for its vision is directed through a surface film and against a strong light. Movement, whether of objects or their shadows, is quickly detected. Changes of bodily color are controlled to some extent through vision. Blind trout are very dark in contrast to the much lighter normal fish in a school. Hearing is limited, for there is neither a tympanum nor external ear. Vibrations produced by a footfall or crunching gravel are recognized. Taste and smell are closely associated, and it seems evident that food in the water may be detected by these senses as also by vision.

Trout are fish of simple habits, possessing none of the finer instincts such as parental care for the young.

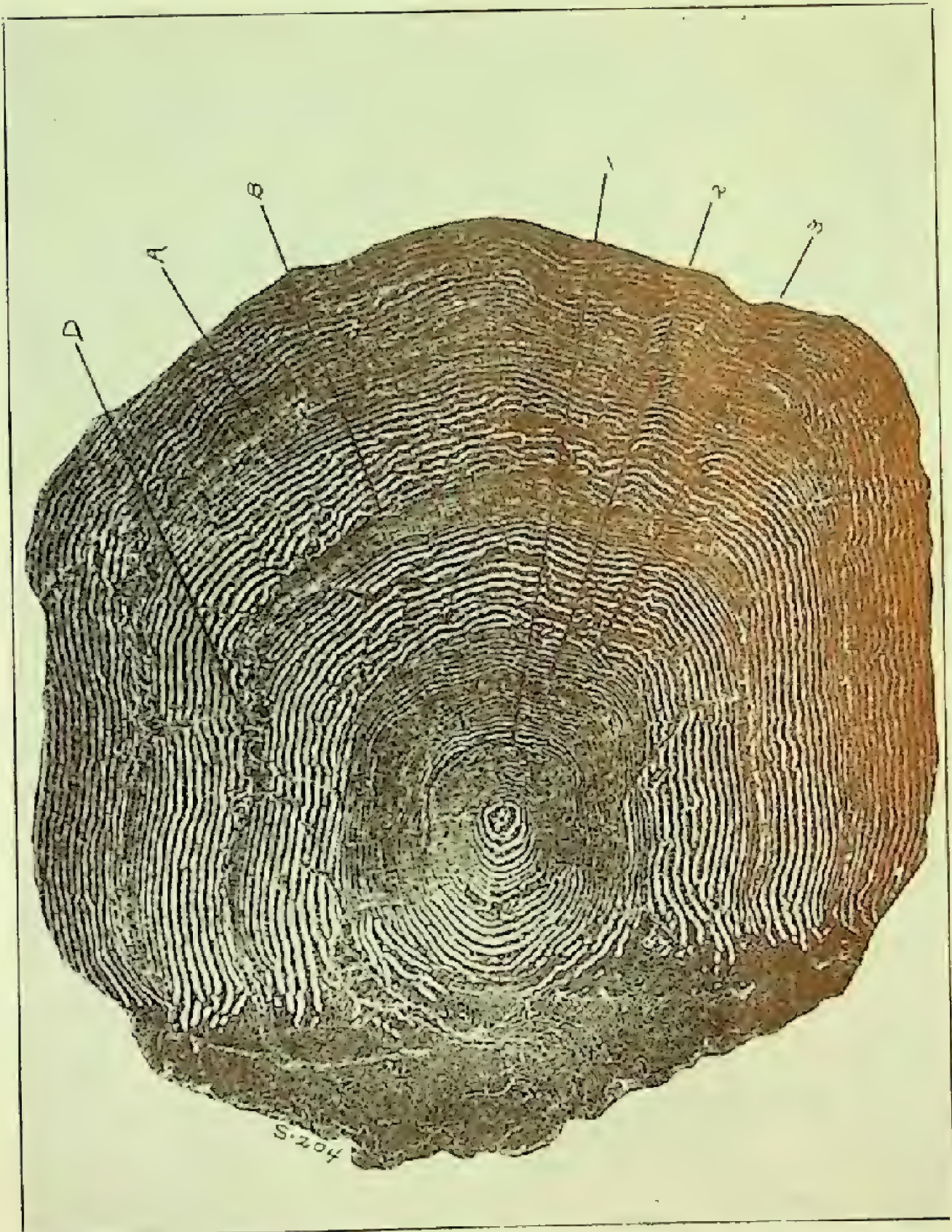


FIG. 37. A scale of a Klamath River steelhead with a three-year stream record. The fish returned to the river a third time after having successfully accomplished two previous spawning migrations.

COLOR

Adult trout, particularly those approaching the spawning season exhibit a varied and brilliant display of color. Young trout, in common with most salmonids, are relatively plain except for parr marks along the sides. There are as many as 10 or 12 of these in some species, fewer in others. They sometimes persist for 2 or 3 years, occasionally remaining in adults. These particular marks may be regarded as a heritage from some primitive ancestor of the various salmon and trouts.

If, with a lens, one inspects the bright lateral stripe of a trout, the color whether black or red is seen to break up into minute specks. A greater magnification will resolve these specks into peculiar black and orange objects known as melanophores and xanthophores. They remind one of splotches of ink. A little further search brings out other elements which are involved in the production of color, and persistent investigation reveals a wonderful variety of chromatophores, pigment granules, and guanine crystals, together with a remarkable and little understood nerve control.

Pigment spots are capable of enlargement or contraction, thus increasing or diminishing the intensity of color. This may at times be brought about so rapidly that one may observe the fading hues as the fish is held in the hand. Something of the color of a fish may be preserved for a time by stripping off the skin, pasting it down on a piece of paper and drying it in the dark. A trout can not be accurately painted as there is no way of reproducing the beautiful metallic and opalescent reflections so often present.

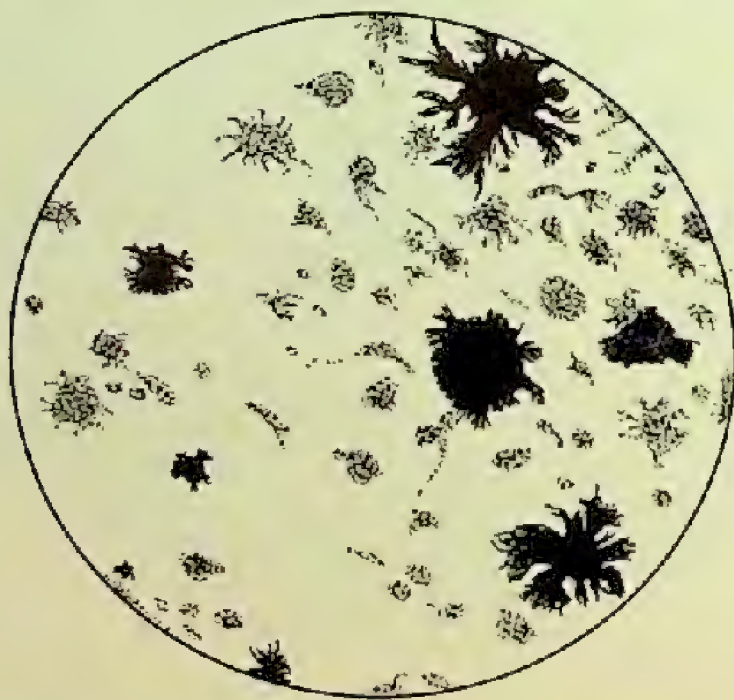


FIG. 38. A bit of trout epidermis, highly magnified to illustrate color pigment. The black spots are known as melanophores; the gray ones (orange in life) are xanthophores.

FOOD OF TROUT

Trout are carnivorous feeders and when considered at large they appear to eat anything that moves and some things that do not. The most delicate and ephemeral insects attract them to the surface at times,

while at others they will swallow bottom larvae, stone- or stick-covered cases and all. They will eat the eggs and young of other fishes or of their own kind. They occasionally gorge until the food projects from their mouths and again they are able to fast for considerable periods without being much the worse for it.



FIG. 33. A mountain meadow where the meandering stream is well supplied with trout food.

In studying the food of trout it is preferable to use net caught fish, thus avoiding a selection of hungry individuals. The stomachs should be opened at once and preserved before post-mortem digestion alters the contents.

The entire food supply of trout is derived either directly or indirectly from the land. If the land through which a stream flows is relatively barren, the food supply in the stream will be comparatively meager, while on the other hand, if the land is covered with vegetation like the forests, flowering grasslands, bogs and mountain meadows, fish food will be abundant because of what falls from the air or is washed into the stream by the rains or melting snows. Trout food is abundant in fertile waters, and waters are fertilized by what they receive from the land.

Deforestation, both from lumbering or fires, and overgrazing are two agencies largely responsible for scarcity of fish food in some regions. Of the two, the latter may perhaps be the more destructive, for what is not eaten by the animals is completely cut up and destroyed, even to the roots, by the sharp hoofs. It thus becomes evident that proper forestry procedure may contribute largely to the conservation of fish.

In so far as we know at the present time, California waters, with the exception of high, alpine, granitic lakes, and limited regions where artificially created adverse conditions prevail, are abundantly supplied with natural food, and the stream growth of trout and other fishes is fairly rapid.

It is thought by many anglers, and apparently with good reason that trout are very careful in their selection of insect food, and with this in mind a large number and variety of artificial lures have been constructed. Some of these resemble real insects with the greatest nicety, while others are admittedly monstrosities. They are often ingeniously made and very beautiful. It is not difficult for one to tie his own flies, make simple repairs to his worn tackle and keep his equipment in good shape. Some part of the pleasure of fishing comes from an appreciation of well kept tools.

Of late years there has been a disposition on the part of experimental investigators to uncover facts which seem to discredit the age old belief in the fine visual discrimination possessed by trout. Possibly the activities of such investigators should be curbed before they succeed in dispelling too much of the glamour attending these remarkable fish. It will be some time, however, before this approaching cloud comes to obscure the entire sky. In the meantime the royal coachman, the pale evening dun, the black gnat, and other old favorites will serve to decorate the fly book, while the occasional skeptic maintains that it is not so much what fly you fish as how you fish it.

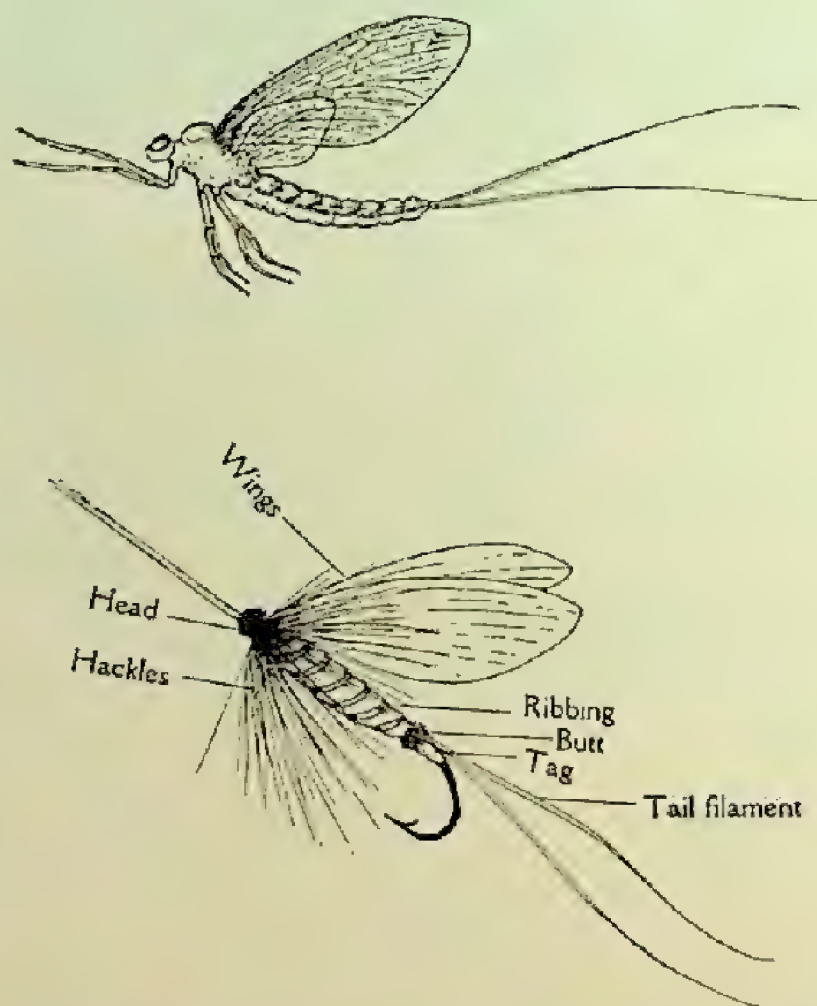


FIG. 40 Above, an ephemeral insect, and below an artificial trout fly that simulates an ephemeral insect.

BARRIERS TO MIGRATION

Trout perform various migrations. No matter where they are they tend to seek larger waters as they grow. They pass from shallow ripples to deeper pools, they drop down stream from small rivulets to the creeks or rivers, and they will pass out into lakes or the open ocean. They will return again to their native streams and tributaries during the spawning period. This migratory instinct permits the individual to attain large size, and at the same time the population increases. A steelhead stream could not support all its fish if a large part of the population did not move out to sea.

An impediment to migration may contribute to depletion or even extinction. Artificial barriers such as dams may check or stop a migration, or a diversion of water may lead to certain death. River pollution may be worse than an ordinary obstruction as it not only destroys the natural food and stops the migrating fish but sometimes kills them besides. Conservation and propagation must take account of such conditions.

Migratory fish are often assisted in passing dams by means of fishways. These embrace pools and little falls, gradually leading from the stream up and over the obstruction. They take advantage of the climbing instinct of the fish, the falling water indicating direction while the pool offers a resting place and room for the necessary start on another leap.

The location and building of a successful fishway involve a knowledge of migrating fish and considerable engineering skill as well.

Diversions, usually caused by irrigation or the use of water for power, should be guarded by screens or deflections which prevent the passage of fish and hold them to the desired channel. These are of various types, some being so arranged as to revolve in a manner to carry over and dispose of floating debris.

The presence of barriers and diversions is no doubt responsible in a large measure for the depletion of trout and salmon. Protective laws and much firmness and diplomacy in their administration seem necessary if serious losses are to be prevented.



FIG. 41. A fishway at Benbow Dam. There are alternating miniature falls and resting pools. Photograph by John Spencer.

ARTIFICIAL PROPAGATION AND DISTRIBUTION

Artificial propagation of trout consists in securing and fertilizing the eggs and rearing the resulting fry and fingerlings until ready for introduction into suitable streams and lakes. At all stages it requires the skill of experienced men, and it is fraught with many difficulties. It is an interesting occupation which appeals to a particular type of

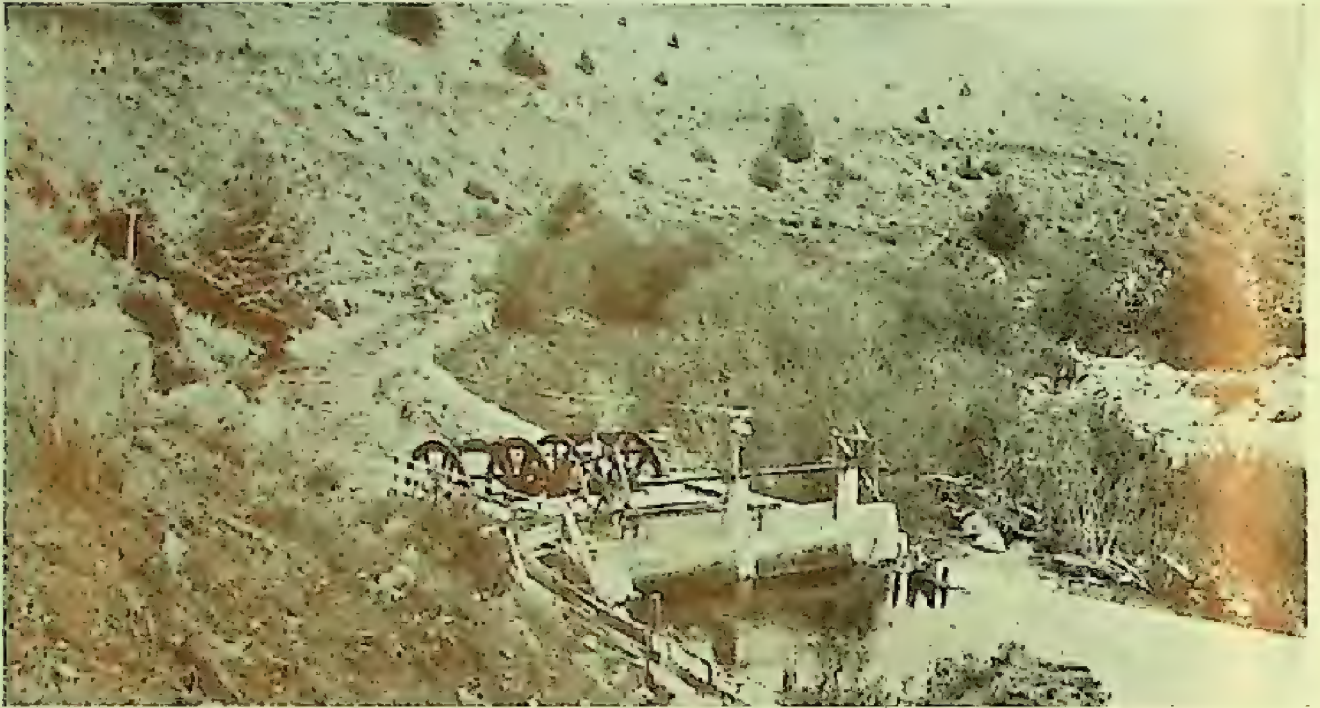


FIG. 42. A rotary fish screen which hinders the passage of small fish into a diversion.



FIG. 43. Spawning wild trout at the Chester Station. The racks rest against the trunk of a fallen pine.

man, as all who have inspected a well administered hatchery with its wonderful exhibit of developing eggs and growing fish will agree. Here under our eyes many secrets which nature had very carefully hidden in the tumbling and foaming waters of our mountain streams are brought to light.

Artificial propagation should supplement rather than supplant natural propagation. At its best it is self-sustained, depending upon brood fish for its eggs, thus taking nothing from the natural propagation of the streams. It accomplishes much when properly directed. It adds to the stock of depleted waters and it introduces fish where none was found in nature. It should not, however, be charged with the



FIG. 44. The Mt. Whitney Trout Hatchery.



FIG. 45. A large distribution truck on the edge of a lake.

entire responsibility of maintaining an unlimited supply of fish against an uncurbed and irresponsible demand.

The success of a hatchery depends very largely upon its water supply. A sufficient supply of unpolluted spring water of a proper

temperature is desirable. Only one California hatchery has such a supply. Most of them receive their water from streams, and they are therefore subject to all the vagaries of stream conditions, such as extreme variation in temperature, loading with silt or mud, pollution, and disease carried by stream fish. With such a water supply there is a constant struggle against harmful factors which are beyond the operator's control. Such hatcheries can not carry fish for a year, nor can they profitably produce very large fish for planting, no matter how desirable it may seem to some.



FIG. 46. Packing fish in the high mountains. Photograph by C. J. Walters.

One of the greatest foes of artificial propagation is disease. The losses from its inroads have never been carefully measured but on every hand they are admitted to be serious. In the streams and lakes, trout are practically free from serious disease, but like human beings, when the population becomes unduly crowded trouble arises. In most cases diseases in the hatcheries are due to protozoans (minute animals), worms, small crustaceans, fungi, and bacteria. If properly diagnosed and treated, the ravages of fish disease may be checked and hygienic methods may prevent its appearance. The State Bureau of Fish Conservation has an agency for the scientific study and control of trout diseases.

The State maintains a large number of hatcheries and egg-taking stations, and some of these as Mount Shasta and Yosemite are annually visited by thousands of people. They produce millions of fingerlings and larger fish which are carefully distributed and planted in an

effort to contribute substantially to the sport of angling.

The distribution of fingerlings (little fish produced by the hatcheries) usually begins in May, but July, August and September are the months of greatest activity. The early plantings often result from the necessary easements where fish become crowded, and these should be made in the headwaters where the native fish are small. Larger fish are available as growth is attained, and these are introduced as the spring freshets subside or the snow retreats in the mountains. In some localities many fish of large size are distributed.

The cost of rearing and distributing large fish is considerable and one may arrive at some notion of it when he considers that it takes

about four pounds of animal food to produce one pound of small fish. Of five-inch fish there are about sixteen or seventeen in a pound, while of nine- to eleven-inch fish there are only two or three in a pound. To the expense of food must be added that of labor and distribution. The cost of distribution rises very rapidly with increased size of fish.

Distribution is carried on by means of railroad cars, especially fitted for the purpose, trucks, pack-horses, and in some cases the cans are carried on the backs of men. A great deal is invested in the necessary equipment for distribution, but its successful operation depends largely upon the friendly cooperation of the railroads, sportsmen's organizations and other groups of willing people.



FIG. 47. Pack train laden with golden trout at Muir Pass. Photograph by F. A. Bullard.

ROUGH FISH AND THE TROUT

Through the ages the native trout have lived, multiplied, and held their own in the presence of the so-called rough fish—minnows, suckers, sculpins, and others. Some western minnows, as the Sacramento pike and the hardhead, for example, grow to large size, and with growth become voracious like true carnivorous fishes. It may be that these minnows, permitted to increase while the trout have become depleted, are correspondingly more dangerous. The suckers are not known to interfere with trout. Sculpins eat both eggs and small fish, but they are fortunately not abundant. The most destructive and despicable rough fish is the introduced carp. Trout may have suffered as much from black bass as from any native fish.

Depletion of the trout has lately attracted attention to almost every possible cause except the increased activities of anglers. A great hue and cry has been directed toward the rough fish. Some of these may be very destructive in certain places, but there appears no direct or very convincing evidence against them. The entire matter of the

ecological relations of these fish and the trout deserves careful investigation and if some species are found to be detrimental, then measures of control, which may take advantage of what is learned of their habits, should be devised.

CONSERVATION

It is a matter of common observation of late years that trout are rapidly becoming less abundant in some quarters and literally disappearing in others. The causes of depletion or extermination are well known, but means of conservation and the reparation of losses are not so apparent.



FIG. 48. Fall Creek. Fish were planted in barren waters above the falls.

Conservation of trout includes (1) the protection of young and adults at critical times and in exposed situations, from enemies, including man, and (2) artificial methods of propagation and distribution. Measures or means of conservation and their rational administration or application rest entirely upon what is learned from careful research. Research in this case includes the discovery of facts and a study of their interrelations. Sound measures of conservation can rest upon nothing else, and laws and regulations resulting from hearsay and guesses are futile. Conservation requires first of all a thorough knowledge of the situation and then a willing or enforced cooperation of all concerned in carrying out such measures as have been devised. Many who have carefully considered conservation in its broadest sense have concluded that education of the public and especially of its younger members, should form an essential part of the program.

The people of this State are responsible for the conservation within its borders of some of the most remarkable and beautiful trout known to the world. They have created a particular agency, the Division of Fish and Game, and honored and trusted it with this responsibility. The future will hold it accountable.

THE SPORT OF TROUT FISHING

There is no sport that has developed greater refinement of apparatus or technique than that of trout fishing. Lures, leaders, lines, reels and rods have reached a degree of adaptability and perfection of beauty in construction and workmanship that is difficult to surpass. The mate-



FIG. 49. A catch of golden trout from Rock Creek near Lone Pine. Photograph by Burton Frasher.

rials of a good outfit are collected from the ends of the earth and when properly finished and fitted in the best proportion, they contribute to an ensemble that is well worthy of admiration. Part of the pleasure and enthusiasm of the angler centers about the fine and well kept tools of his sport.

There is no need here to direct the novice or to enlarge upon the outfit or the ways of the successful angler.³ Two or three popular books will offer ample food for thought, together with a sufficient volume of contradictory statements and lengthy arguments as to whether it is best to fish up or down stream, use wet or dry flies, tie your own or use the store product, select a tapered or a level line, a silver or copper spinner, or what not. Perhaps the most fortunate thing in relation to the suggestions of the various books is that the angler need not take them too seriously nor is he thereby forced to abandon his own

³ An excellent article under the authorship of Donald H. Fry, Jr., entitled "Trout fishing in southern California streams—instructions for the beginner," appeared in CALIFORNIA FISH AND GAME, vol. 24, pp. 84-117, 1938.

initiative. The inquiring fisherman will meet with friendly suggestions on every hand. The supply houses are replete with tackle and information. Much of it is good, some of it indifferent or even bad. It is the privilege of the angler, and a part of the game to choose.

ANGLERS' CONTRIBUTIONS

Anglers may offer substantial contributions to the ichthyology of trout. Their notes should take account of locality and date. Color descriptions should follow the nomenclature of external anatomy. The spots may be enumerated and localized by dividing the body into four parts by means of a vertical line through the anal opening across the lateral line. The size of the scales is expressed by counting the lateral



FIG. 50. Opening day on the San Gabriel and an angler on every pool.

series. Measurements should include the length from the tip of the snout to the base of the caudal fin, the depth at the deepest part of the body, length of head and of maxillary, length or height of fins, especially the length of the caudal from its base to the tips of the middle rays. (See Fig. 52.) The skin of a trout may be removed and dried, thus preserving the scales and much of the color.

Scales for age determination should be removed from near the middle of the body. They should always be labeled with the species name, the length of the fish, the locality and date.

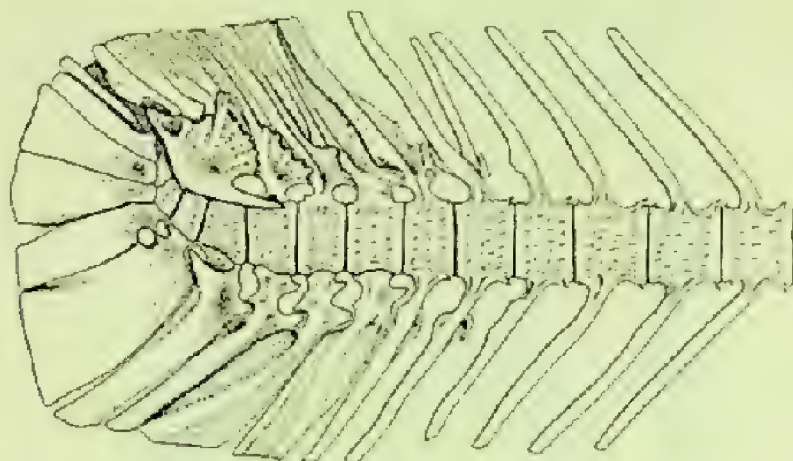


FIG. 51. A dissection of the tail with 13 vertebrae. The last two or three should not be overlooked in vertebral counts.

Vertebrae may be accurately counted after slightly cooking the flesh in hot water and brushing and scraping it away. The last small and partly developed vertebra in the tail should be included. (See Fig. 51.)

DESCRIPTIONS OF CALIFORNIA TROUT

As in the case of some peoples, American Indian and Asiatic Mongol for example, so with the trouts, cut-throat and rainbow alike, the distinguishing traits which separate them are difficult to set down in writing. Yet when one becomes familiar with them they may usually be recognized with certainty. The shape of the head and body, the dentition, the red throat mark, the squamation, the habits, etc., are not in each case always to be depended upon. Large acquaintance with them will demonstrate the futility of attempting an identification of their species by means of artificial keys or brief descriptions.

Coast Rainbow Trout

Salmo irideus Gibbons⁴

Rainbow trout inhabit the coastal streams from the northern border of the State southward wherever the water is of sufficient volume to support them. Entering the streams as steelheads, they migrate to the uppermost tributaries, where they spawn and then return to the sea. The progeny of the steelheads remain for a time as stream trout

⁴The use of the specific name *S. irideus* is here used instead of *S. gairdneri* for the simple reason that no particular trout can be recognized with certainty from Richardson's description published under the latter name.

Of this name, Gunther (Catalogue of fishes, vol. 6, p. 118, 1866) says "The material on which this species has been founded was quite insufficient for that purpose, and the species for which this name has been intended is not likely to be ever recognized."

Jordan (Copeia, no. 121, p. 86, 1923) believed that Gairdner was referring to the blue-backed salmon, *Oncorhynchus nerka*. This seems possible as Richardson quotes Gairdner's notes: "Colour—Back of head and body bluish-grey; sides ash-grey. Belly white. The only trace of variegated markings are a few faint spots at the root of the caudal."

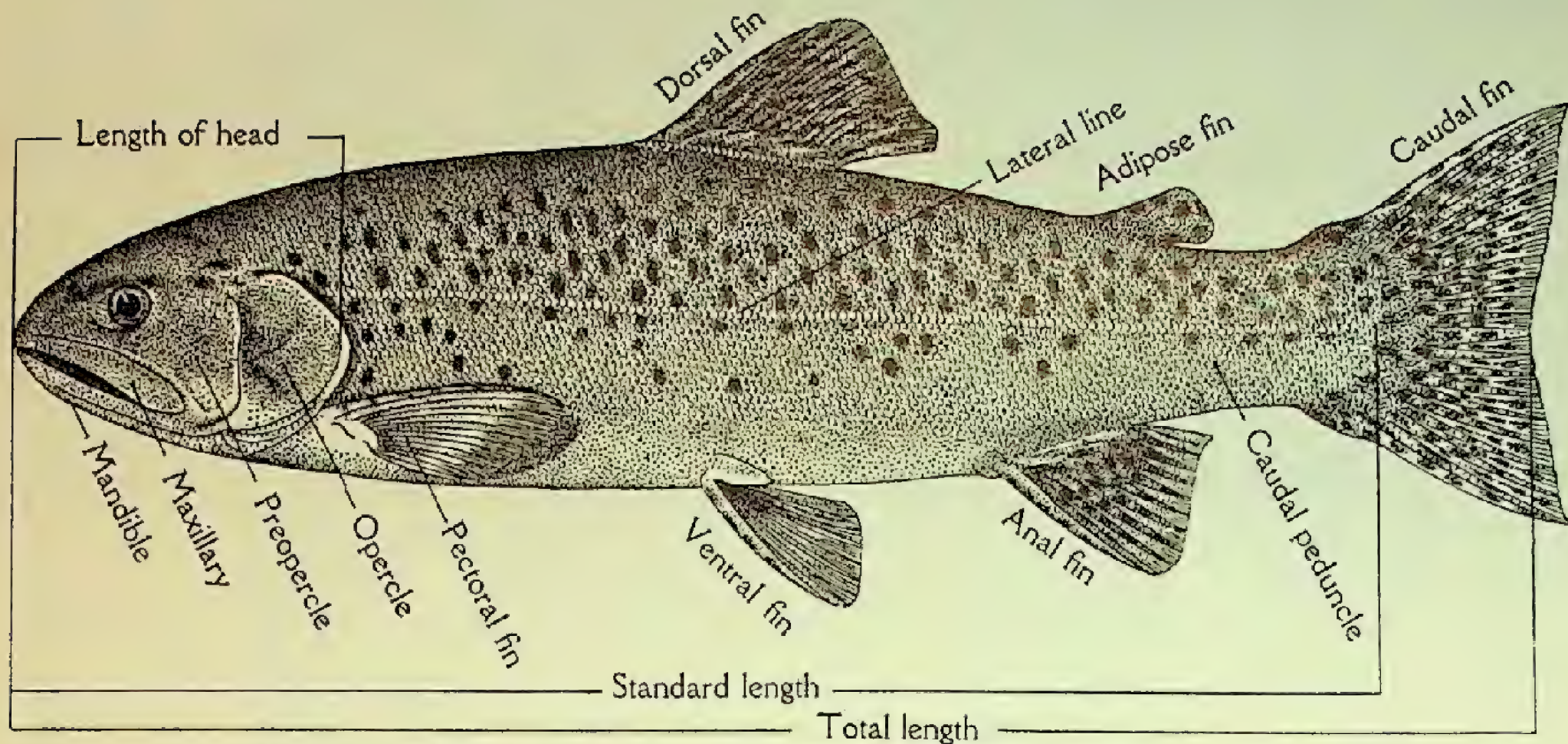
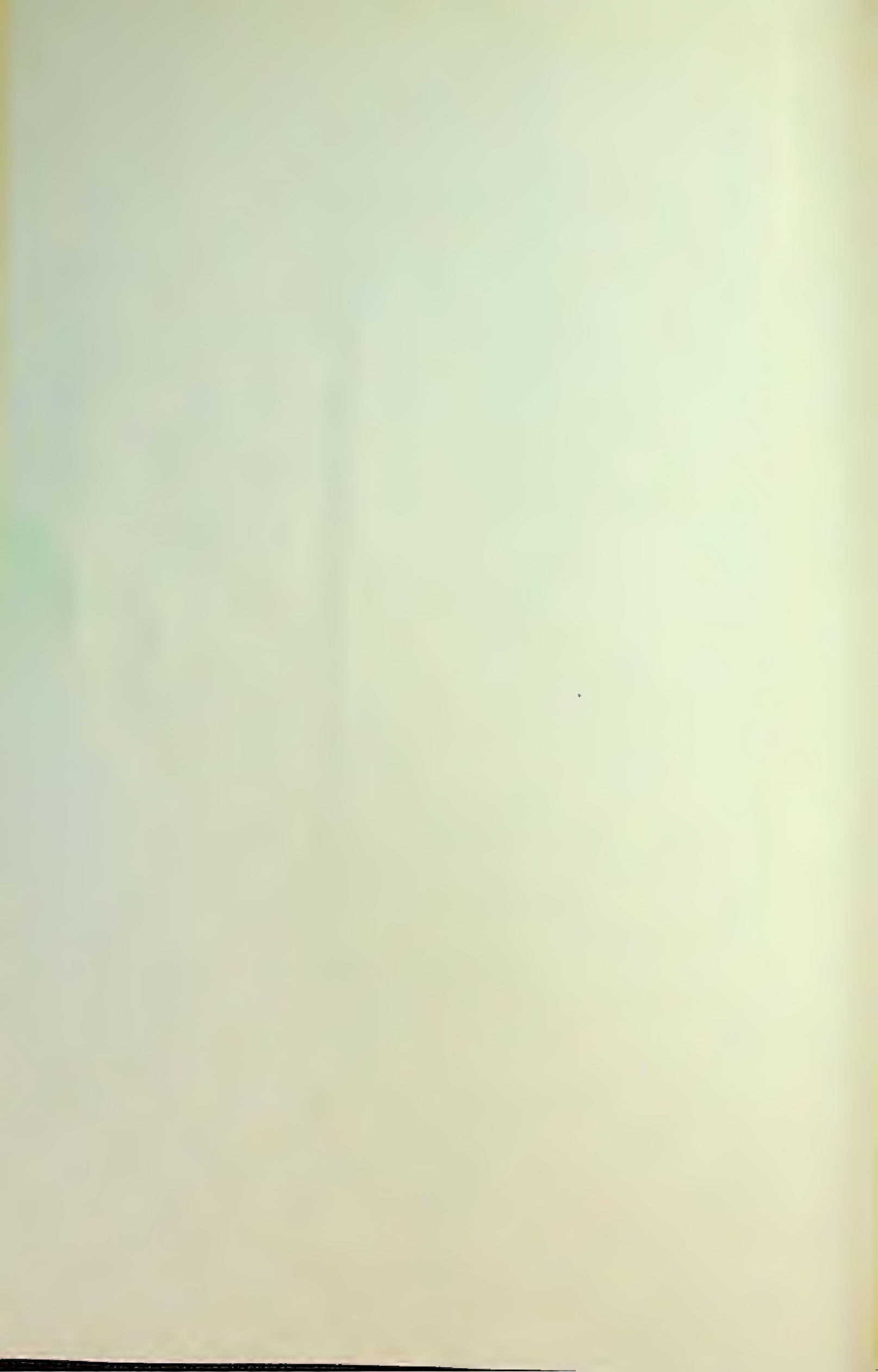


FIG. 52. Drawing of a trout which may be of use in making notes or interpreting descriptions.



PLATE I. Coast rainbow trout, *Salmo irideus* Gibbons.



drifting toward deeper water as they grow larger, some remaining three years or more before entering the ocean. In large bodies of water, lakes and river channels, are resident trout which behave in their spawning migrations just as do the steelheads, seeking turbulent, well aerated water in which to deposit their eggs.

The coast rainbow trout or some of its near allies, has been extensively propagated by artificial means and widely distributed over the world. It is able to adapt itself to considerable ranges of temperature and a variety of natural conditions. It is generally conceded that some of its brilliant color, its sprightliness, and its fighting spirit is lost when it is removed from its native waters. However, some anglers hold that introduction to foreign streams is attended with an improvement of these qualities.

The color forms are varied and individuals from one stream are apt to differ from those of another. A typical rainbow may resemble that presented in the color plate or it may be much darker or lighter, with the lateral color stripe broader or narrower, the fins lighter, pink or bronzy, the dark spots less numerous, larger and more rounded. In lakes or in silty water the spots contract and become linear, and the general color is relatively pale and silvery.

The scales are large, the lateral series numbering 120 to 150 or so.

Growth varies with conditions. In the streams 4 or 5 inches are often attained the first year and a length of 6 to 9 inches or more during the second. Examples measuring 9 or 10 inches or even more have been reported for the first year. In general a 9- or 10-inch fish is in its third year or it may be older.

An 18- to 22-inch fish may weigh $2\frac{3}{4}$ to $4\frac{1}{4}$ pounds; a 24- to 28-inch fish, $5\frac{1}{2}$ to $9\frac{1}{4}$ pounds; a 30- to 34-inch fish, 10 to 12 pounds. Rainbow trout weigh much more than cut-throat trout of the same length.

Shasta Trout

Salmo stonei Jordan

The Shasta trout should be referred to as *Salmo stonei*, as it and *Salmo shasta* are synonymous, and *S. stonei* was first described. No specific characters can be found to distinguish between these two nominal forms.

The writer has never had an opportunity to carefully examine specimens of the Shasta trout. It is described as a variant of the rainbow, inhabiting the waters of the upper Sacramento and its tributary the McCloud. Writers have distinguished it by the smaller scales, 150 to 165 in the lateral series, and by its color.

It is olivaceous above and paler below, with a brownish-red stripe. The opercles are washed with brownish-red. The under parts and the fins are yellowish. The tips of the dorsal, anal and ventrals are white.

Particular attention was early directed to the trout of the Sacramento and McCloud rivers because of its wide use in fish cultural operations and its popularity with sportsmen. It is difficult to find any anatomical characters to distinguish it from the rainbow of the coast. It has somewhat smaller scales, but it attains no larger size as has been said. One authority states that it has 63 vertebrae instead of 60 as in the case of the steelhead. Coast steelheads have from 60 to 63 or more

vertebrae. A careful count of the vertebrae of 175 Klamath River steelheads stands as follows:

Number of vertebrae-----	60	61	62	63	64	65
Number of examples-----	7	42	57	50	15	4

The curve or variation here exhibited is normal and it is typical of most specific characters which are capable of enumeration. A count of a like series of Shasta trout would probably show similar variation.

Kern River Trout

Salmo gilberti Jordan

As its name implies this form is limited to Kern River.

It resembles the coast rainbow in form and color as distinguished from the golden trout. It is profusely and closely spotted over the entire body and fins, a concentration of spots occurring on the caudal peduncle.

In life the dorsal surface is dark olivaceous or lighter and usually with fine yellow or orange specks. A broad, rich rosy band extends from the opercle to the anal base, the band growing wider toward the middle and somewhat darker posteriorly. Below the lateral band the body is strongly suffused with greenish-blue. The ventral surface of soiled white is washed with gold. The cheek and opercles are rosy, the head above is greenish-olive, the side of the jaw brownish. The dorsal and caudal are tinted with blue and olive, the pectorals, ventrals, and anal suffused with brown and pink, the tips of ventrals and anal white. The body and fins are closely spotted, the spots of the fins oval or elongate. The upper part of the head bears round spots, and there are a few similar spots scattered on the sides of the head.

Considerable variation in the number, size and shape of the spots appears, and the general brilliance of color differs among individuals.

Trout from Kern Lake, a widening of the river, are larger and less brightly colored than those of the river proper.

The scales number about 155 in the lateral series, actual counts resulting in 151 to 162.

The Kern River trout is not easily distinguished from the Shasta trout. It may possibly be a color variant among others of a more or less differentiated group of fine scaled rainbow trouts which inhabit the series of rivers entering the Great Valley from the western slopes of the Sierras. It so happens that particular attention has been directed to the trout of Kern River and to those of the upper Sacramento with its tributary the McCloud, while the Feather, American, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Kings and Kaweah river systems have been ignored. If the two trouts in question are to be regarded as distinct species, the geographic range of each must be considered and this involves the identity of the trout native to the streams mentioned above, a matter of no little difficulty.



PLATE II. Kern River Trout, *Salmo gilberti* Jordan



South Fork Golden Trout*Salmo aqua-bonita* Jordan ⁵

This trout inhabits the South Fork of the Kern River and Voleano Creek. It, like some other species, has been successfully introduced elsewhere, notably Cottonwood Lakes and Cottonwood Creek.

This is the most brilliantly colored trout. It occurs at an elevation of about 10,000 feet. It has fewer spots on the body than *S. whitei*. The scales are very small, 180 or thereabouts in the lateral series.

In life the top of the head, the back and the upper part of the sides are light yellowish olive. On the sides, extending from the head to the caudal peduncle, is a bright earmine stripe. The sides below the lateral line are bright golden yellow, fading below into greenish white. On the belly is a broad cadmium or orange-yellow area from the throat to the anal fin, the color deepest between pectoral and ventral fins. Ten or so vertically oblong parr marks appear on the sides. The cheeks and opercles are bright rosy. The dorsal fin is tipped with light orange; ventrals and anal tipped with white. The dorsal and adipose fins are well spotted; the other fins without spots. The head and body are frequently spotted down to the lateral line, spots covering the caudal peduncle. In many individuals (*S. roosevelti* Evermann) the spots are less numerous, sometimes confined to the region of the caudal peduncle.

Individually, much variation in color is seen, the general type and plan persisting. The parr marks usually persist. Introduction into new localities may be attended with considerable variation, particularly in loss of color and increase in size.

This trout and likewise *S. whitei* are to be regarded as having a rainbow ancestry, the great reduction in the size of the scales and their consequent increase in number being associated with alpine, *i.e.*, boreal conditions.

To prevent the complete extinction of this species is a problem for the present and future.

Soda Creek Golden Trout*Salmo whitei* Evermann

The trout of Soda Creek, Coyote Creek, Wet Meadow Creek and Little Kern River were referred by the author of the species to *S. whitei*. It will be noted that of these streams, Coyote Creek is tributary to Kern River and is thus separated from the Little Kern basin.

The presence of small black spots on the top of the head and all but the lower one-third of the side is said to distinguish this from other species of golden trout. The described differences between this and *S. aqua-bonita* in so far as color is concerned appear to be slight. The scales of the latter appear to be larger, however.

In life the dorsal region of head and body is a light yellowish-olive, the color becoming lighter and assuming a light lemon tint on the lower sides. The ventral surface is reddish-orange between the throat and anal fin. A rather narrow, orange-red lateral stripe extends

⁵ Brian Curtis, in a study of the habits of the golden trout (CALIFORNIA FISH AND GAME, vol. 21, pp. 101-109, 1935) seems to have shown that no constant character distinguishes *S. roosevelti* from this species.

from opercle to the base of caudal. Subocular area pinkish, cheek lemon, opercles orange. Dorsal fin light greenish-olive, tipped with yellow. Lower fins yellowish, the ventrals and anal tipped with white. Upper half of body and head, dorsal and caudal fins are abundantly provided with round and oval black spots, all smaller than the pupil. A few spots appear on the opercle.

There are about 200 scales in the lateral series. They are minute, frail and well imbedded.

This trout is fully as handsome as *S. agua-bonita*. The parr marks are said to be always present, they are rather narrow and a series of intermediate small rounded ones are present in a line below.

It is said that the trout of Coyote Creek exhibit greater variation than those of other localities; also that trout localized in the stream because of falls show an appreciable amount of distinctive coloration.

Culver Lake Trout

Salmo rosei Jordan and McGregor

This species was described from trout taken in an unnamed lake, later called Culver Lake, in the High Sierras. The lake is tributary to the Big Arroyo, a stream flowing into Kern River. It lies north of Five Lake Basin at an altitude of about 10,500 feet.

It is a large-headed, stocky fish with relatively small, generally scattered spots. The maxillary is long, and the upper contour of the head is markedly concave.

Its relationships are said to be with the golden trout of the region. There is difference of opinion as to whether this is a native fish or one introduced through artificial stocking.

In life it is described as having roundish black spots on the back and along the sides above the lateral line, some of which are nearly as large as the pupil. The spots on the sides below the lateral line are dash-like and less distinct. Spots are almost entirely absent on the top of the head. The ventrals are slightly dusky, with some red. There is a rather conspicuous rosy band along the lateral line. A faint cut-throat streak occurs on inner edge of the mandible.

San Gorgonio Trout

Salmo evermanni Jordan and Grinnell

The native trout of the upper Santa Ana River in the San Bernardino Mountains is referred to this species.

It is distinguished from the coast rainbow by the finer scales, and the large round spots which are scattered evenly over the upper part of the head and body. The head is large and long and the snout sharp.

The scales in the lateral series number 162 or so.

An exact count of all the spots on one side of the body in an example resulted in 82, and most of these were about the size of the pupil.

The trout of this species are isolated from the rainbows of the lower courses of the river by high falls. Individuals may pass down stream, and they do at times, but no trout from the river below enters their domain above the falls. However, several years ago a ditch was



PLATE III. Golden trout, *Salmo gairdneri* Jordan.

constructed which diverts water from above the falls to feed a small lake. The lake is stocked with rainbow and Loch Leven trout. Both fishes are said to have invaded the territory of the San Geronio trout and it is to be doubted if one could find a specimen of the native trout at the present time.

Eagle Lake Trout

Salmo aquilarum Snyder

This species is indigenous to Eagle Lake and its tributary stream Pine Creek.

It is robust in form with a deep caudal peduncle and very large adipose fin. The rayed fins are large and strong.

In life, the body above and down the sides nearly to the lateral line is a rich dark olive, each scale brassy and very conspicuous. The sides below the olive region and the ventral surface are deep coppery-red with bright metallic reflections. The sides of the head are cherry-red, very rich in color. A trace of red beneath the mandible; iris brassy. The pectorals are broadly and conspicuously edged with olive. The color as here described is of a male at the time of spawning. The female is very different. It is light olive above where each scale is silvery with greenish reflections. The sides are lighter, the scales more green than those above, the ventral surface silvery, tinted with pink. A very distinct pale reddish stripe extends along the side of the body, mostly below the lateral line. The cheeks and opercles are red, the iris orange. The ventrals and anal are suffused with red and distinctly edged with the same. When in the water the males are easily distinguished as their sides appear a deep coppery-red and the cheeks are particularly brilliant. There are very few black spots on the head. The middle of the back from the occiput to the dorsal is without spots. The unpaired fins and the upper part of the body have large rounded or elongate spots.

The lateral series of scales numbers 136 to 140; scales above lateral line 29 to 32; anal rays 11.

The flesh of this trout is deep red, very firm and fatty, far superior to that of the Tahoe trout. A considerable number were seen in May during the spring migration of 1913. They were very uniform in size, measuring 18 inches or so in length.

The native trout of Eagle Lake leads a precarious existence. The only spawning and nursery stream is Pine Creek, a small tributary with a fitful flow. Often many spawning fish are cut off by low water before they return to the lake, and many young trout are destroyed in like manner. Formerly Indians, and later some of the white population, by building weirs and traps and arming themselves with spears, took a considerable toll from the migration.

The species is of particular interest, as closely allied to and scarcely distinct from the rainbows of the western slopes of the Sierras, it occurs in the Great Basin drainage. The other fishes of Eagle Lake, suckers and minnows, belong to the Lahontan fauna, while the Tahoe trout, characteristic of the Lahontan region of the Great Basin is not found there. The royal silver trout, although a member of the rainbow group, does not appear to be closely related to the Eagle Lake trout.

According to report it is difficult to catch this trout in the lake.

Royal Silver Trout
Salmo regalis Snyder

This species is known only from a few examples caught in Lake Tahoe. There is every reason to believe that it is rare and not simply overlooked. Fishermen are apt to confuse silvery examples of the Tahoe trout with this fish, although when placed side by side, a glance serves to reveal the difference.

It is a small-headed fish with a short, rounded snout, a narrow, weak maxillary scarcely extending beyond the orbit. The opercles and branchiostegals are thin and papery. The jaws are weak and the teeth small. The gill rakers number 19 to 21, small and pointed. The scales number 144 to 150 in the lateral series; they are very thin and not deeply imbedded. The fins are all thin and relatively frail, the pectorals and ventrals sharply pointed.

The royal silver trout is distinguished at once among all other California species by its unusual color, deep blue on the dorsal surface which in some lights is slightly shaded with olive, the blue extending downward on the sides to about the sixth row of scales above the lateral line, where it gives place to the most brilliant or burnished silver. The silver sheen dulls toward the ventral surface, the abdomen, throat and chin being dead white. No dark spots appear except a few very small ones on the dorsal and caudal fins. No red or yellow color is to be seen anywhere except on the cheek, where it glows faintly through the silver.

Nothing is known of the spawning habits of this species, and the young have never been recognized.

The species appears to be related to the emerald trout, *S. smaragdus* of Pyramid Lake, a fish equally rare and possibly soon to disappear as one of the last relics of the ancient Lake Lahontan. Both are apparently of rainbow stock long separated from those fishes west of the Sierras.

It has been taken with both fly and spinner. Its capture furnishes a real surprise to the angler when a prodigious leap from the surface of the water in true rainbow fashion reveals a dash of blue and a shimmer of silver not generally associated with trout.

Coast Cut-throat Trout
Salmo clarki Richardson

This trout is a native of the streams in a narrow coastal region extending from Redwood Creek northward. It has been recorded from Eel River, but examples from that stream have never come to the writer's notice. Considerable seining there has not caught any young of the species.

The writer fished the streams of this region in 1897. At that time trout of this species were abundant in Redwood Creek, but almost impossible to find in either the Klamath or Smith rivers. Observations continued through a period of years since that time have added nothing to this apparent condition except that the trout have become considerably depleted. Just why Redwood Creek should be favored as a habitat for this species instead of Eel, Mad, Klamath or Smith rivers

is an example of some of the puzzling questions relating to adaptation and geographic distribution which frequently confront the investigator.

During the migrations of some years the cut-throats appear to about equal the rainbows in number in Redwood Creek, while usually the rainbows are more numerous.

Small cut-throats may be taken in some of the tributaries of the lower part of Klamath River but no adults have as yet been recorded there in a winter migration. An occasional cut-throat steelhead makes its appearance among the late summer rainbow steelheads. These look like the latter in shape and color, and unless the scales are carefully observed they may pass as rainbows. They are then very rare, however, one cut-throat among thousands of rainbows.

The scales in the lateral series number from about 160 to 200 or so. Between the lateral line and the back there are 34 to 39 or 40.

In the month of January or sometimes earlier the cut-throats come into Redwood Creek to spawn. They find their way up the tributaries, and those entering Prairie Creek seem to be particularly well colored. In seeming keeping with the dark redwood forest with its fern lined mossy banks, the fish are very sombre. Their backs and sides are suffused with deep olive. In some examples the lower sides are yellowish. There is generally present an indefinitely outlined purplish lateral stripe extending from the opercle to the caudal fin. The pectorals are tinged with yellow, and the ventrals with salmon-pink. The jaws and sides of the head are yellowish. The upper part of the opercle is yellowish or occasionally golden, the lower part sometimes purple. The red gash under the mandible is bright salmon or red, very conspicuous and always present. An occasional individual has a small rounded golden spot somewhere on the lower part of the body.

This particular characteristic, a coinlike golden spot, may be seen on an occasional brightly colored Tahoe cut-throat.

The black spots are large and pretty well scattered over the head and body. Actual counts show from 26 to 71 on the head; 322 to 577 on the body. All of the fins bear spots.

Tahoe Cut-throat Trout

Salmo henshawi Gill and Jordan

The Tahoe trout is a mountain cut-throat indigenous to streams of interior drainage. It is to be caught in Lake Tahoe and other waters of the Truckee system and in Walker, Carson and Owens rivers. Whether it is native in the latter stream is questioned. Its distribution has been somewhat extended by artificial propagation.

This trout occupies a region of great diversity of natural conditions and it seems to respond accordingly. Its color varieties might offer an open and fertile field to the systematist prone to describe geographic forms.

It would perhaps be a matter of convenience to apply a specific name to the Pyramid Lake trout, its distinctness being a matter of color and restricted distribution, the habitat being Pyramid and Winnemucca lakes and the lower Truckee River.

Although spawning occurs in the streams tributary to Lake Tahoe in April, examples in nuptial color may be seen even late in June. The

males are then of a dark, yellowish-olive color, with a faint metallic sheen, the dark color being usually uniform from the back to the ventral surface. On the side is a broad pinkish stripe, indefinite in outline



FIG. 53. Tahoe cut-throat or black-spotted trout, *Salmo leushawi*. Photographs of specimens (female above, male below) from Heenan Lake, Alpine County, May, 1939, by A. C. Taft.



FIG. 54. A pair of silvery Tahoe trout caught in deep water with trolling tackle.

and about ten scales wide. It originates on the opercle and extends to the tail where it gradually fades out. Each scale included in this stripe, and also in a broad area above and below, is narrowly edged with pale

yellow. The sides of the head and a triangular spot above the axil of the pectoral are scarlet or yellowish-scarlet. The under surface of the lower jaw has two parallel stripes of bright red. Even the tongue is tipped with crimson. One or more small, coin-like, golden spots may occasionally be found on the head. The entire head and body together with the unpaired fins are marked with dense brownish-black spots, usually larger than the pupil and rounded oval in outline, widely spaced and fairly regular in distribution. Because of these spots, the Tahoe cut-throat is often called black-spotted trout. The females are lighter in color, though preserving the same general pattern.

Frequently individuals, large in size, fat and in fine condition are taken in deep water. They are very silvery and the spots are narrow and elongate. They are locally known as silver trout, and check lists



FIG. 55. Dark colored Tahoe trout caught near the edge of the green water.

still recognize them as *Salmo tahoensis*, a proceeding entirely unwarranted.

The Tahoe trout is a comparatively slender fish with a rather long and pointed head. Examples, 18 to 20 inches long, weigh from $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds; 24 to 28 inches, $3\frac{1}{2}$ to $7\frac{1}{2}$ pounds. The scales run from 153 to 163 in the lateral series and 29 to 38 above the lateral line. Gill rakers, 23 to 25; branchiostegals, 10 or 11; cæca, 70 to 85.

The lake fish feed largely on minnows which occur abundantly and of several species. At times they consume insects which have fallen upon the surface or are brought out by the streams. They are not to be regarded as surface feeders, and as the summer season progresses they go to deeper water, following the minnows which in turn seem to follow the plankton.

When taken with light tackle the Tahoe trout puts up a strong fight, but not so spectacular as that of the rainbow. They are said to reach a weight of 20 or 30 pounds.

Marked depletion of the Tahoe trout resulted first from the activities of market fishermen. It is now continued by anglers who persist in catching the small fish of the tributary streams before they have an opportunity to enter the lake where they would soon reach a large size.

Piute Trout

Salmo seleniris Snyder

This newly described species is an isolated variant of *S. henshawi*, differing markedly in the absence of spots on the body, the more slender form, and the relatively small and more numerous scales.

The outstanding characteristic of this trout is the color, well portrayed in Plate IV. No two observers agree in a description of its colors, tints and shades, some of which seemingly come and go with every changing whim of the fish. Moreover, its swimming movements are often accompanied with opaline reflections of varied intensity, and the skin in some places has a peculiar translucent appearance, so much so that on the head some of the cranial bones are partly outlined through the overlying tissue. A sudden disturbance will occasion the appearance of much green color on the body, thus imparting a greenish olive to the dorsal surface and a paler green to the region below the lateral stripe. The ventral surface may at times darken considerably.

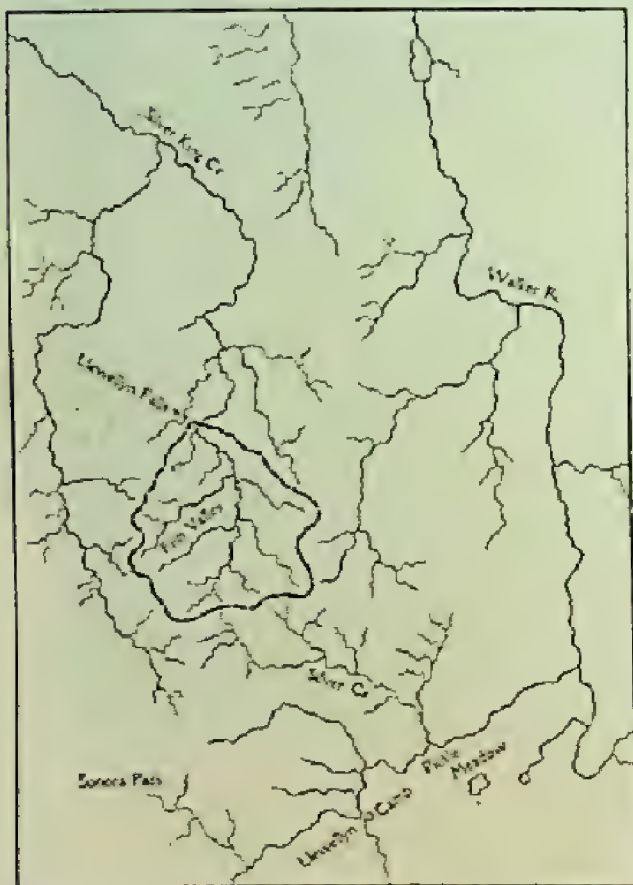


FIG. 56. Sketch map showing Fish Valley, habitat of the Piute trout.

The normally clear white ventral surface is unusual, particularly on the throat where it forms an advantageous background for the extensive orange-red areas beneath the mandible. As in the case of other cut-throats, an occasional example bears one or more small, golden, coin-like spots, located anywhere, but usually on the ventral surface. There are no dark spots on the body and they are not numerous on the dorsal and caudal fins. In some examples the caudal is almost immaculate. The major parr marks are ten in number, the first immediately bordering the gill opening, the last at the end of the caudal peduncle. All are crossed by the lateral line, the posterior ones bisected by it, the anterior ones two-thirds below. Of the secondary row, sixteen in number, every alternate spot dips between the nearby primary ones. The mid-dorsal region is marked by a narrow dark line.



PLATE IV. Puite trout, *Salmo seleniris* Snyder.

The body is comparatively long and slender, so much so as to attract attention at once. The fins are rather weak.

This trout is found only in the little streams of Fish Valley, a remote region in Alpine County east of the Sierra Divide. Its native habitat is restricted by Idwellyn Falls, which form an impassable barrier between the waters above and Silver King Creek below, which in turn flows into Carson River. The waters of the latter eventually disappear in Carson Desert to the eastward. Carson River was once tributary to the Quaternary Lake Lahontan which covered a considerable area in Nevada.

Trout from below the falls are different from those immediately above in that their bodies and dorsal and caudal fins are well covered with large and very conspicuous roundish black spots. They are also considerably deeper and more robust in appearance. The colors are not nearly so bright. An enumeration of the spots on several examples from the stream below the falls will be of interest.

Spots on side of head-----	10	18	5	5	4	5	6
On body above lateral line-----	32	93	38	58	37	36	22
Body below lateral line-----	25	57	34	17	34	8	33
On tail above lateral line-----	20	36	26	24	12	19	17
Tail below lateral line-----	18	21	19	13	17	9	17
On dorsal fin-----	33	34	38	41	25	28	30
Caudal fin-----	55	66	67	21	33	13	43

As the region of Fish Valley presents an apparently clear-cut and unusual biological demonstration in nature, fishing there is now prohibited by order of the State Division of Fish and Game. To further insure the survival of the species, a number of piute trout have been transplanted to some formerly barren lakes near Lake Tahoe, where at last reports they were thriving.

Colorado River Trout

Salmo pleuriticus Cope

The Colorado River trout has come into the State by way of overflow waters passing into Salton Sea. It has been variously reported as abundant or scarce, but no authentic information relating to it is at hand. It is improbable that it will thrive in the waters of the sea because of high temperatures, and it may not maintain itself for lack of spawning places.

The relationships of this species are to be traced to the trouts of the eastern slopes of the Rocky Mountains and the Great Basin including *Salmo henshawi* of Lake Tahoe and *S. utah* of the Bonneville system. Through these a relation may be seen with the cut-throats of the Columbia system.

This is described as a brightly colored form with a red lateral band and with red or orange fins. The spotting is variable, some examples having the body fairly covered while others have spots only posteriorly. The head is usually immaculate.

Salton Sea examples are said to be very light in color.

The scales are small, there being 185 to 190 or more in the lateral series.

Loch Leven Trout
Salmo levenensis Walker

The Loch Leven trout of Scotland and the brown trout of Europe (*S. fario*) were early introduced into the waters of this country. In the hands of fish culturists they were eventually cross bred to such an extent that perhaps now no clear strain of either remains. Characteristic of hybrids the fishes now held in breeding ponds exhibit a variety of color pattern, occasional individuals resembling one or the other of the parent stock, while many differ from both.

This fish is valued particularly because it spawns in the fall and affords a relatively large growth before the time of summer planting arrives, and also, it seems to thrive in certain situations not so well adapted to other forms. It is not always easy to catch and is therefore less likely to be fished out.



FIG. 57. Loch Leven trout, *Salmo levenensis*. Photograph of fish at Rush Creek Egg Collecting Station, October, 1939, by Elden H. Vestal.

The back and sides are brown, olive-brown, greenish or grayish. lighter on the sides, and silvery or almost white beneath. The back is covered with dark spots, very black in some examples, while on the sides the spots are red, surrounded by a light ring of varying width.

This trout has been planted in many parts of the State and is now to be found in many streams and lakes, particularly in the Sierras.

Dolly Varden Trout
Salvelinus spectabilis (Girard)

In California this species is found only here and there in the upper tributaries of Sacramento River, especially the McCloud. It extends northward, growing more plentiful toward British Columbia and Alaska, and grading into *S. malma*, if indeed it really differs from that species.

It may be regarded as a native western representative of the brook trout, which it resembles somewhat in size, color and form. It is, however, more slender, and the back and the dorsal fin are without blackish vermiculations, markings and blotches.

Dolly Varden trout are not in favor with fish culturists because of their predatory habits.

In life the color is olive above, lighter or darker as the case may be, light olive or grayish or greenish on the sides and white beneath. The

iris is brassy. The fins are light olive with a brassy metallic sheen. The anterior rays and membranes of the ventrals are orange, whereas the distal half of these rays is edged with dead white. The anterior two or three of the anal rays are orange, the lower anterior edge of the fin white. The spots on the sides of the body are bright orange or dark yellow.

The Dolly Varden is a beautiful fish, perhaps a little slow for the impatient angler and not overly demonstrative when hooked.

Eastern Brook Trout

Salvelinus fontinalis (Mitchill)

The eastern brook trout was early introduced into the State where it now thrives in the cold waters of the high mountains. It is extensively propagated and used to stock depleted or barren waters.

The mottled or marbled color pattern, red spots on the sides and the reddish lower fins, broadly edged with white, serve to distinguish this trout, or rather charr, from the black-spotted natives.

In life the head, dorsal part of the body, dorsal and caudal fins are variously spotted and vermiculated with dark olive or black. The sides are covered with yellowish, greenish and bright red spots which form the centers of grayish or greenish circular areas. The lower parts of the sides and the ventral region are reddish, sometimes very deep and brilliant in color. Lighter examples have the head and back grayish-green, mottled with dark green or olive-black. The red spots on the sides are surrounded with light greenish-brown or gray areas. The ventral surface is tinted with pink.

The parr marks, eight or so in number, often persist in large fish.

The scales are very small and so deeply imbedded as to usually escape notice.

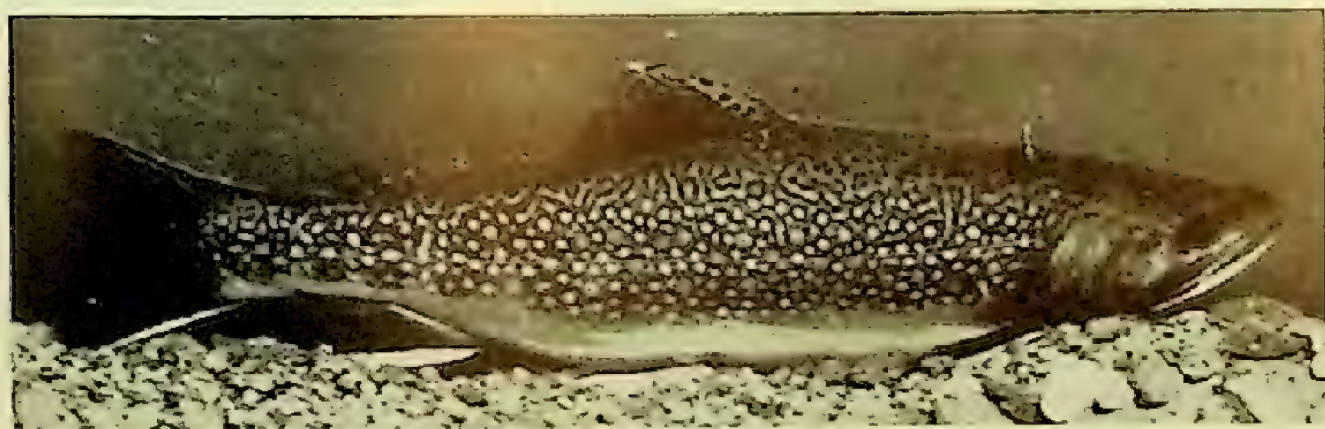


FIG. 58. Eastern brook trout, *Salvelinus fontinalis*. Photograph of a fish at Carmen Lake Egg Collecting Station, October, 1939, by Elden H. Vestal.

This species is abundant in the Tahoe region, the Sierran lakes and streams, and in scattered localities in mountainous regions. It exhibits great variation in color. It is wary and some skill is required in its capture.

It spawns from early in October until well into December. The eggs are very small when compared with those of native trout, and they are deposited in a nest-like cavity and covered with gravel.

Mackinaw Trout*Cristivomer namaycush* (Walbaum)

The Mackinaw or Great Lakes trout was introduced into Lake Tahoe from where it has spread to neighboring lakes in the same basin.

This trout may be known by its long, pointed head, very long and slender maxillary, narrow caudal peduncle, deeply emarginate caudal fin, and by the color.

In life the head is dark greenish or olive, reticulated or clouded with blackish. The body is greenish or olive above, lighter on the sides and soiled white below. The back and sides are covered with large round or variously elongate yellowish, greenish or pink tinted spots. The dorsal and anal fins are spotted or vermiculated. The paired fins and the anal are immaculate, and tinted with light pink, yellow and green.

Much variation in color appears, some examples being darker than others, the vermiculation and spotting varying as do the tints and shades.

The scales are very small, there being 200 or so in the lateral series.

This species spawns in the lakes, where it occasionally reaches a weight of 15 or 20 pounds. It is not greatly esteemed by anglers as it is rather heavy and sluggish. It is an omnivorous feeder with a ravenous appetite. Its further distribution in the State is not to be encouraged.

THE DEER OF CALIFORNIA, WITH PARTICULAR REFERENCE TO THE ROCKY MOUNTAIN MULE DEER¹

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Origin of North American Deer

The origin of deer in North America is an interesting problem that has not been solved to the satisfaction of all scientists, even though volumes have been written on the subject.

Deer apparently came to this continent by way of a land bridge from Asia to Alaska, and thence south into the Americas. The original prehistoric representatives were small animals quite different from the fine, large deer of today. Some of the South and Central American species of brockets are quite tiny, but these are considered as degenerate species rather than near relatives of the ancient races. There are no fossil remains of brockets north of southern Mexico.

Two different types of modern deer have developed in the United States from the original stock and are given the generic name of *Odocoileus*.

Characters of the Genus *Odocoileus*

In speaking of the relationship of deer, Dixon (1934) says, "The mule deer belongs to the order ARTIODACTYLA or Even-toed Ungulates, and to the Cervidae or 'deer' family. The genus *Odocoileus* as described by Rafinesque (Atlantic Journal, Vol. 1, 1832, p. 109) is placed by Gerrit S. Miller (Bull. 128, U. S. Nat. Mus., 1924, p. 484) between the genus *Cervus* (elk) and the genus *Mazama* (brockets). Two noteworthy characters which separate the deer family from other living ungulates of North America are the possession of antlers and certain dermal glands. The antlers of deer are often incorrectly referred to by sportsmen and others as 'horns.' However, true horns are derived from cuticle, as claws and nails are. Horns are *hollow* and are usually present in both sexes. With the exception of the pronghorned antelope, horns are *permanent unbranched structures*. On the other hand, antlers are true bone, not hollow, and are normally grown and shed once each year. Antlers are usually branched and, with the exception of caribou and reindeer, are normally borne only by the males of the species."

The antlers, being one of the most outstanding characteristics of the genus, deserve a little more attention here. From one to three months after the rut, bucks shed their antlers and the new growth

¹ Submitted for publication, March, 1940. All photographs and drawings by author.

begins immediately. The growth is very rapid and is completed in less than 150 days. The growing antler is composed of soft, blood-carrying tissue covered with what hunters call "velvet."

The manner of growth and development of the antlers in members of the deer family has been the object of controversy for many years, but it is generally agreed by those who have given it study that the growing antler, although cartilaginous in appearance, is in reality a fibrous network developing from a cap of undifferentiated connective tissue. This soft, round-topped cap forms first at the corona of the antler but progresses farther from the head as the antler develops. Each separate fork thus formed will have its own cap. The ossification takes place under this cap in a hollowed crater. The antler is first formed in its maximum diameter and does not increase after the ossification. Ossification begins near the exterior surface and progresses toward the core, continuing for some time after the shedding of the velvet and adding to the strength and weight of the antler.

There are two distinct blood supplies for the growing antler. One, which is interior, forms the characteristic bony structure from the calcium that it carries. The other carries the blood throughout the velvet covering of the growing antler and supplies the bone-forming medium to the outer portions of the antler as well as bringing warmth to the exterior surface. There is little mixing of the blood supply of the velvet with that of the interior of the antler, since each is a separate system of arteries and veins.

When the antler has reached full size, the increase in the deposit of bone around the corona and base reduces the flow of blood, causing the velvet to dry and begin to separate from the antler. The animal now shows evidence of an urge to remove the velvet. Whether this urge is caused by itching or some other factor is not definitely understood. The blood flow does not entirely cease at this time, for in most instances, there is blood in evidence when the velvet is being rubbed off. The blood flow to the interior of the antlers continues for some time after the velvet is removed. The supply of blood to the interior and to the corona is finally completely shut off by the hardening of the antler base and corona, at which time the antler becomes a fully matured, hard, smooth, tapering weapon.

Distribution of Deer in North and South America

One group, the white-tailed deer, spread over the eastern part of North America and westward as far as the Cascade-Sierra Nevada mountain barrier, even crossing it in some places. It extends southward through Mexico, Central America, and South America to the Straits where several related families developed. From the Mississippi River westward and northward to southern Alaska and southward to the tablelands of Central America is found the other group which includes the black-tailed and mule deer. The white-tailed group is apparently the older and probably the parent stock. Scientists have divided both groups into various species and subspecies that have developed definite characters due to different geographical, climatic and environmental conditions. These characters are constant in the animals of particular regions, making this method of classification practicable.

Distribution of Deer in California

In California the mule deer subspecies predominate. There are only a few scattering records of the western white-tailed deer. Along the boundaries of their various ranges, shown on the map, there is a considerable amount of intergradation. As figure 59 clearly shows, California has an excellent representation of the deer family. Nearly

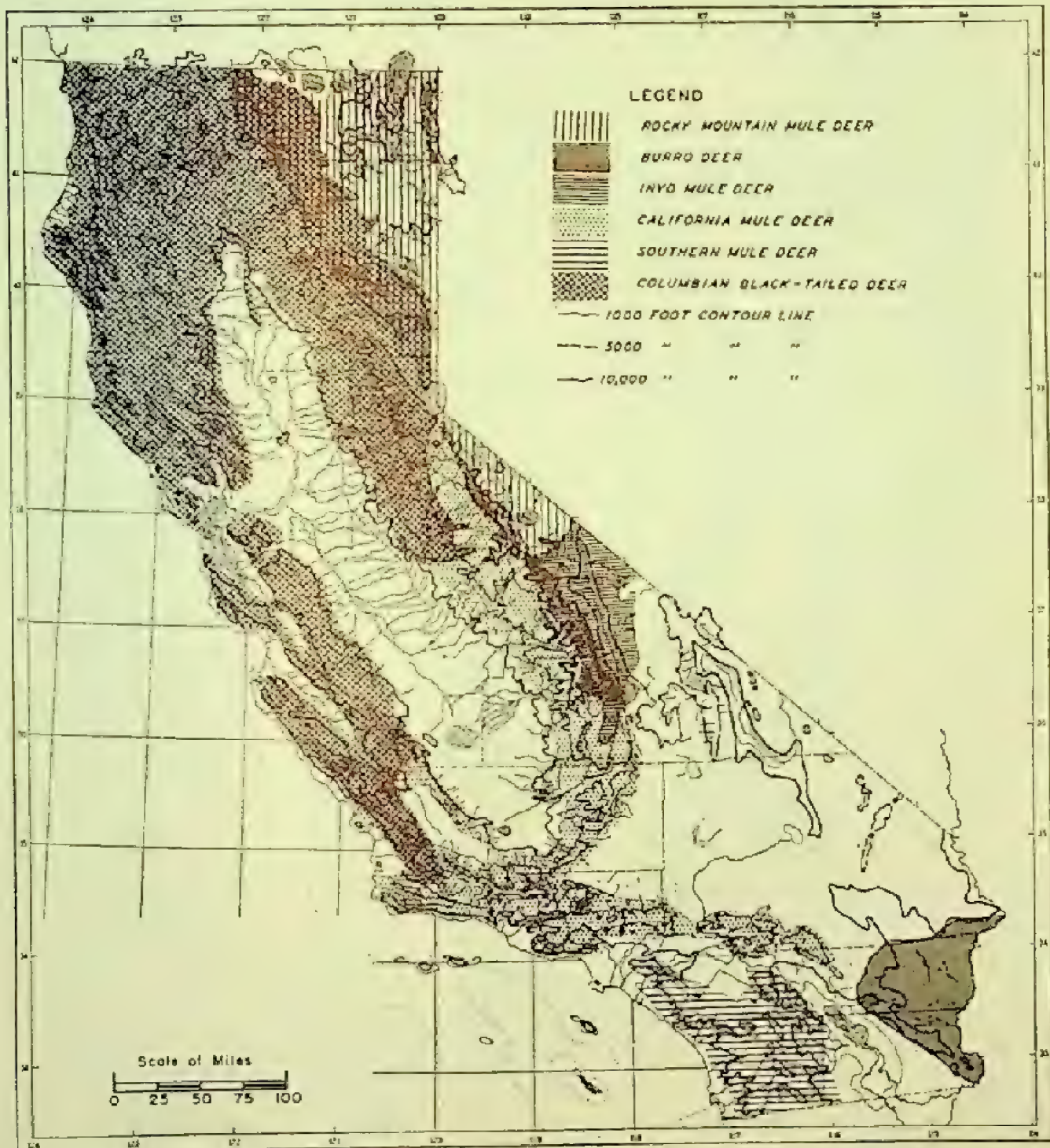


FIG. 59. Range of the six subspecies of the mule deer in California.

half of the deer range in California is populated with Columbia black-tailed deer, the other half by the various kinds of mule deer.

There are 155,652 square miles in the State, of which 84,300 square miles or 54 per cent can be classed as deer range where these animals may be found in varying numbers. Of the 84,300 square miles of deer range, there are about 46,000 square miles which come under

the classification of good deer country and support a population of about seven deer to the square mile on the average. About 20,000 square miles may be classified as fair deer territory, with a population averaging about 3 deer to the square mile. There are about 18,000 square miles of poor deer range that support an average deer population of about one deer to the square mile.

By multiplying the number of square miles in each type of range by the average number of deer per square mile and then adding these numbers, we find that the deer population for the State is approximately 400,000 head.

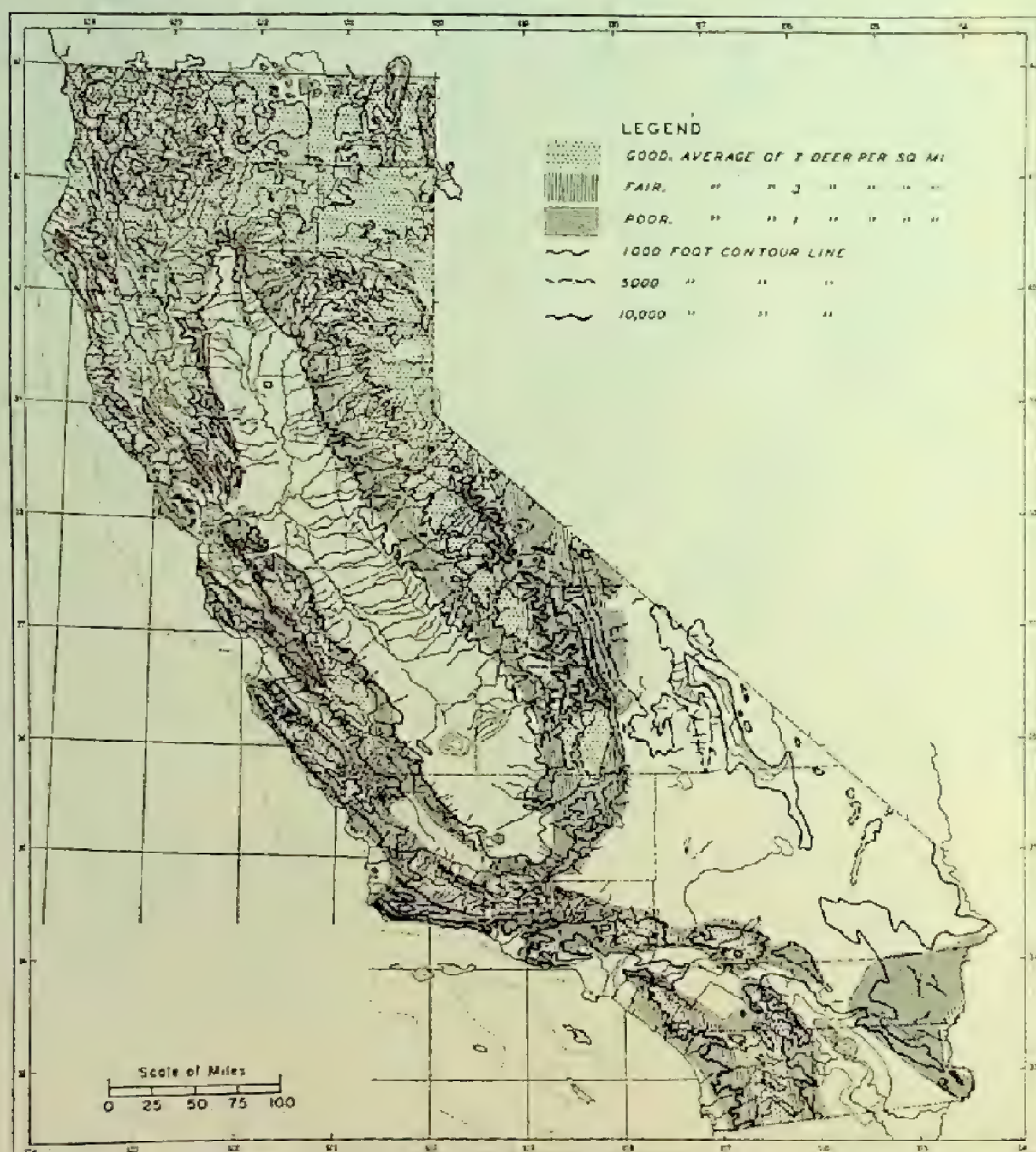


FIG. 50. Deer range in California, showing relative density of population.

The approximate area of range for each subspecies of deer in California is as follows:

	Square Miles	Percentage
Columbian black-tailed deer.....	43,500	44.5
California mule deer.....	22,500	23.2
Rocky Mountain mule deer.....	15,500	15.9
Southern mule deer.....	6,100	6.3
Inyo mule deer.....	5,250	5.4
Burro deer	4,600	4.7
Total	97,450	100.0

Of the total area, there are about 13,150 square miles of overlapping range between the ranges of adjoining subspecies. Thus we again find the total deer range in the State to be about 84,300 square miles.

The average counts per square mile on ranges of the different subspecies of deer have shown the following to be approximately correct:

Columbian black-tailed deer.....	4.3 per square mile
California mule deer.....	4.5 per square mile
Rocky Mountain mule deer.....	5.8 per square mile
Southern mule deer.....	2.6 per square mile
Inyo mule deer (partially estimated).....	2.2 per square mile
Burro deer (estimated).....	0.2 per square mile

By multiplying the number of deer per square mile by the number of square miles in their range, we find the population of the various subspecies to be about as follows:

Columbian black-tailed deer.....	186,900
California mule deer.....	101,500
Rocky Mountain mule deer.....	90,000
Southern mule deer.....	16,000
Inyo mule deer	11,500
Burro deer	920
Approximate deer population.....	406,820

This is a second method of computing the deer population of the State.

Migration of Deer

The deer that summer at high altitudes migrate to lower areas in winter below the heavy snow line at about 4,500 feet. In the different subspecies, there is considerable variation in the time and amount of migration. In many parts of the State there is no migration at all due to the lack of snow or other conditions that make migration necessary.

Life History and Breeding Habits

The rutting or mating season varies with the region and the subspecies. In California, where there are many different types of climate and geographical conditions within the deer range, this is very evident. In the case of one subspecies, there is a difference of two months in the rut within the extremes of its range.

The gestation period of deer is about 210 days or seven months. It has been found that the normal reproduction is about $1\frac{1}{2}$ fawns to the doe. Of course, there are some does that do not have fawns each year or have lost them in some manner. Stokes (ms.) noted that

even where the ratio of bucks to does was 1 to 4.12 that in five mature does accidentally killed, there were the embryos of twin fawns.

In the Rocky Mountain mule deer range of northeastern California the buck to doe ratio is about 1 buck to 3.62 does. In other parts of the State the ratio varies from 1 buck to 1.62 does to as much as 1 buck to 7.5 does. These high ratios are in regions that are heavily hunted. Such a ratio as 1 buck to 7.5 does is not particularly dangerous, as deer are decidedly polygamous.

Food Habits

Deer are both grazers and browsers, depending on the amount of browse or grass available. Browse seems to be preferred, but considerable quantities of grass and weeds are eaten.

Predators

The principal natural enemies of deer are mountain lions and coyotes. It is estimated that an adult mountain lion averages killing at least one deer per week throughout the year. Coyotes kill more deer in winter than in summer, especially where the snow is fairly deep.

Disease

Disease takes considerable toll of deer in some areas. The most serious one is caused by the bacillus *Actinomyces necrophorus* which attacks the throat, mouth, feet, and in the advanced stages, the lining of the stomach. This disease is related to foot-rot of sheep and is sometimes called calf diphtheria. Stagnant ponds and puddles harbor this bacillus for considerable periods after they have once become infected.

ROCKY MOUNTAIN MULE DEER

Distribution

The Rocky Mountain mule deer total about 90,000 head in California and range in the following territory: the eastern half of Siskiyou County; all of Lassen County; all of Modoc County; parts of eastern Shasta County; eastern Plumas, Sierra, Nevada, and Placer counties; most of Alpine County; and the northern half of Mono County. These counties make up the plateau region of northeastern California. (See map, fig. 59.)

From counts made on the winter ranges of Modoc and Lassen counties, it is evident that there are about 65,000 Rocky Mountain mule deer in these two counties at that season. There is a considerable influx of Oregon deer into that region during the winter months, especially into northwestern Modoc County in the area extending from Blue Mountain westward toward Clear Lake and southward toward Mowich Butte and the head of Black Canyon. In fact, there is such an over-population in parts of that region that a serious range condition may develop because of over-browsing of the principal food plants.

Rocky Mountain mule deer are to be found in varying numbers in almost all types of habitat within their range, but they seem to prefer the more arid, desert-like situations, in which sage brush (*Artemisia*),

juniper (*Juniperus*), antelope brush or bitter brush (*Purshia*), mahogany (*Cercocarpus*), and bitter cherry (*Prunus*) predominate.

Food Habits

The favorite food plants throughout most of their range are mahogany, bitter brush or antelope brush and bitter cherry. Nearly all other common plants are eaten in varying degrees. Some plants commonly eaten are aspen (*Populus*), willows (*Salix*), chinquapin (*Castanopsis*), huckleberry oak (*Quercus vaccinifolia*), Pacific service berry (*Amelanchier florida*), currant and gooseberry (*Ribes*), wild rose (*Rosa*), various deer brushes (*Ceanothus*), sage brush (*Artemisia*),



FIG. 61. Over-browsed mahogany, Modoc County, 1934.

buckwheat (*Eriogonum*), Pacific fescue (*Festuca pacifica*), Nevada blue grass (*Poa nevadensis*), giant rye grass (*Agropyron spicatum*), and wild blue grass (*Poa secunda*). Stokes saw deer eating green grass, juniper, bitter brush, mahogany, sage, Scotch thistle and alfilaria during the winter and early spring months.

The feeding time varies with the weather, the phase of the moon, the time of the year, and type of country. During the open season the feeding time of the sexes may vary. Throughout most of the

year the principal feeding is early in the morning and after four in the afternoon. This is particularly true of the seasons of plenty. During the cold, snowy, winter months, when food is hard to obtain and a considerable amount of it is required to keep up body heat and energy, deer feed at all hours of the day and night. During the rutting season, feeding is often erratic. This is especially true of the bucks which may go for considerable periods of time without eating at all. During the hunting season, when many hunters are on their range, bucks apparently do a major part of their feeding at night. Stokes noted that as soon as the snow began to melt under the junipers and at the bases of sage brush clumps, the deer started hunting for the grasses growing around them.

Antlers and Pelage

Antlers are shed from the middle of January to about the middle of April. Most mature bucks in good condition have lost theirs by the end of February and the immature bucks generally lose them a little later. New antlers commence growth immediately following the shedding of the old. The growth is extremely rapid. While the antlers are growing, the bucks remain on the open slopes, points and benches where the brush is short or scattering so as not to injure the antlers which are soft and sensitive. They try to keep out of situations where if startled, they might strike them on limbs or other projections.

Massive antlers will be fully grown in about 150 days. Thus, an average buck with antlers 25 inches long must maintain a growth of 0.16 inches per day. Development is most rapid during the early growth, and after the forks are formed growth is less rapid.

The antlers of the Rocky Mountain mule deer are massive but do not differ in other respects from those of the black-tail or any other subspecies of mule deer found in this State.

The figures illustrate common types and the normal sequence of antlers in the Rocky Mountain mule deer. Figure 62*a* shows the normal yearling or forked horn corresponding to the spike of the black-tail. Figure *b* shows the normal two-year old or three-pointer. Figure *c* shows the next in sequence ordinarily, although some deer are large three-pointers rather than four-pointers. Figure *d* is the typical adult antler, but with added age. Figures *e* and *f* are often developed with variations. Very often the figure *f* type may have numerous small snags and protuberances projecting from all angles. After passing the peak of physical perfection, bucks ordinarily lose points, but retain the full spread as in figures *g*, *h*, and *i*.

Figure 62*i* illustrates a typical so-called "Pacific buck" which may be found in any subspecies of mule deer, including the black-tail. The "Pacific buck" is not a species or subspecies of deer, but a condition brought on by age. "Bench-legged bucks," "brush bucks," "cactus bucks," and in fact all of the various odd-named bucks are only age, individual and environmental variations of the subspecies of deer found in that locality.

Figures 63*j*, *k*, and *l* correspond to figures 62*a*, *b*, and *c* except both antlers are shown to indicate the ordinary increase in spread. Figures *m* and *n* correspond to figures *f* and *g*, showing the spread.

Figure *o* shows an advanced age buck that has dropped down to a three and two-point head with knobs for brow points or eye-guards. Figure *p* shows the typical "Pacific buck" or aged buck. Figure *q* shows a high-antlered "Pacific buck" type. The point sequence of the high-antlered type may be the same as in the figures of the normal head. The same may be true of the wide, flat-antlered type as shown in figure *r*.



FIG. 62. Rocky Mountain mule deer antlers. *a* to *i*, inclusive, show side view of normal antler point sequence from first antlers (forked horn) through prime of life to decadence or old age.

Figure 63s is the ordinary "stag type" or "knot-head" with stubby antlers remaining in the velvet indefinitely or for the life of the animal. There is considerable variation in stags; some being like that shown in figure *s*; some normally formed but remaining in the



FIG. 63. Rocky Mountain mule deer antlers. *j* to *p*, inclusive, show head-on views in the same sequence as *a* to *i* in figure 62. Sketches *q* to *s* show individual types. *p* represents average type of "Pacific Buck" or decadent buck. *q* represents high antlered old forked horn or "Pacific buck"; *r*, the flat-antlered type; *s*, the typical stag or "knot-head."

velvet; while others are partially shed of the velvet and are semi-solid in structure.

There is no set rule regarding antlers, but these illustrations show some of the typical examples. They are secondary sexual characters which vary considerably with age and also with individuals.

There are two distinct types of pelage in the adult Rocky Mountain mule deer. The hairs of summer and winter coats are quite different in diameter, shape, length and color. The "red" or



FIG. 64. Rocky Mountain mule deer doe, showing the shedding of winter pelage. Lassen County, April, 1934.

summer coat is finer, shorter, and straighter than the winter coat. The individual hair is whitish at its base, and the terminal two-thirds becomes reddish-brown, particularly on the upper part of the body. Some black-tipped hairs are scattered throughout. The "red" pelage is shed in late summer or early autumn, when the animal acquires the "blue" coat of winter which is made up of longer, larger, and much more kinky hairs. Hairs from the dorsal region of the animal are black-tipped with a sub-terminal band of buff. The base of the hair is pale drab or brownish slate on the upper side and whitish on the under side.

Shedding of the summer and winter coats varies with individuals and different geographical regions. Bucks and does without fawns ordinarily shed their summer pelage earlier than does with fawns. Bucks in good physical condition shed sooner than those in poor condition. The summer coat is shed late in August or early in September and the winter coat in April and early May in Modoc County. Immediately after the completion of the fall molt the animals appear "blue," but as the winter hair grows out the color becomes brownish.

Comparison with Adjoining Subspecies

The Rocky Mountain mule deer may be distinguished from the Columbian black-tailed deer by the following characters. In size, the former is considerably larger with a more bulky, robust appearance.



FIG. 65. Typical tails of California deer. *a*, western white-tailed deer, *Odocoileus virginianus ochrourus*; *b*, Rocky Mountain mule deer, *O. hemionus hemionus*; *c*, burro deer, *O. h. eremicus*; *d*, Inyo mule deer, *O. h. inyoensis*; *e*, one type of California mule deer, *O. h. californicus*; *f*, second type of California mule deer, *O. h. californicus*; *g*, southern mule deer, *O. h. fuliginatus*; *h*, Columbian black-tailed deer, *O. h. columbianus*. (Hybrids show every type of intergradation between the two subspecies involved.)

The whole body of the mule deer appears lighter in color (grayish rather than brownish). The strikingly large, white rump patch is much more evident than the small, insignificant white area which borders the tail of the black-tail. The sides of the face, nose, cheeks and the upper part of the throat are paler, being whitish or pale gray rather than brownish or buffy. The tail is white with a black tip and is noticeably constricted at the base. (See Figs. 65 and 66.) The tail of the black-tail is brown or black dorsally with a white under-surface and is much broader. The metatarsal gland of the Rocky Mountain mule deer averages five inches long as against a little over three inches for the Columbian black-tail. It is naked for about half of its length on the under side. In summer, the Rocky Mountain mule deer is yellowish-brown on the upper part of the body rather than reddish russet.

The Rocky Mountain mule deer is separable from the California mule deer by the larger size, darker upper parts of the body, and the larger white rump patch which encircles the tail (the dark, upper surface of the body not extending down toward the root of the tail in a V-shaped pattern or all the way down the tail, as in most individuals of the California mule deer). The dark spots on the sides of the lower lips are smaller, the ears are longer and woolier. The metatarsal gland is much longer, averaging $5\frac{3}{32}$ inches instead of $3\frac{1}{14}$ inches. The tail does not have a median stripe in any pelage.

The Rocky Mountain mule deer differs from the Inyo mule deer in being slightly larger in size and light yellowish-brown rather than yellowish in general tone of color. The brow patch is lighter colored, with a smaller V-shaped mark. The chin has little or no median stripe, and the spots on the sides of the lower lips are less prominent. The rump patch surrounds the tail without a V-shaped projection from the dark, upper surface of the body toward the root of the tail. The white of the under-surface does not extend forward onto the breast. The ears are longer and woolier and the metatarsal gland averages longer ($5\frac{3}{32}$ inches as compared to $4\frac{21}{32}$ inches).

MULE DEER STUDY

Many areas in Modoc, Lassen, Siskiyou, Shasta and Plumas counties have been covered in this study of Rocky Mountain mule deer. The study, conducted by the Bureau of Game Conservation, began during the winter of 1933-34. During that winter in Modoc, Siskiyou, Shasta and Lassen counties, a total of 9,263 head of mule deer was observed on the study areas. Of these, 1,306 were bucks, forked-horns or better, and 143 were spikes. This left a total of 5,690 does and 2,124 fawns. The sex ratio was 1 buck to 3.9 does.

During the winter of 1934-1935, a total of 26,473 mule deer was observed, of which 4,172 were bucks, including 207 spikes. There were 14,885 does and 7,416 fawns. The sex ratio was 1 buck to 3.5 does.

In the winter of 1935-1936 a total of 8,928 mule deer was counted. 1,353 were bucks, including 125 spikes. There were 5,361 does and 2,214 fawns. The sex ratio was 1 buck to 3.9 does.

In the winter of 1936-1937, a total of 21,517 deer was observed. 3,904 were bucks, of which 147 were spikes. There were 13,652 does and 3,961 fawns. The sex ratio was 1 buck to 3.5 does.

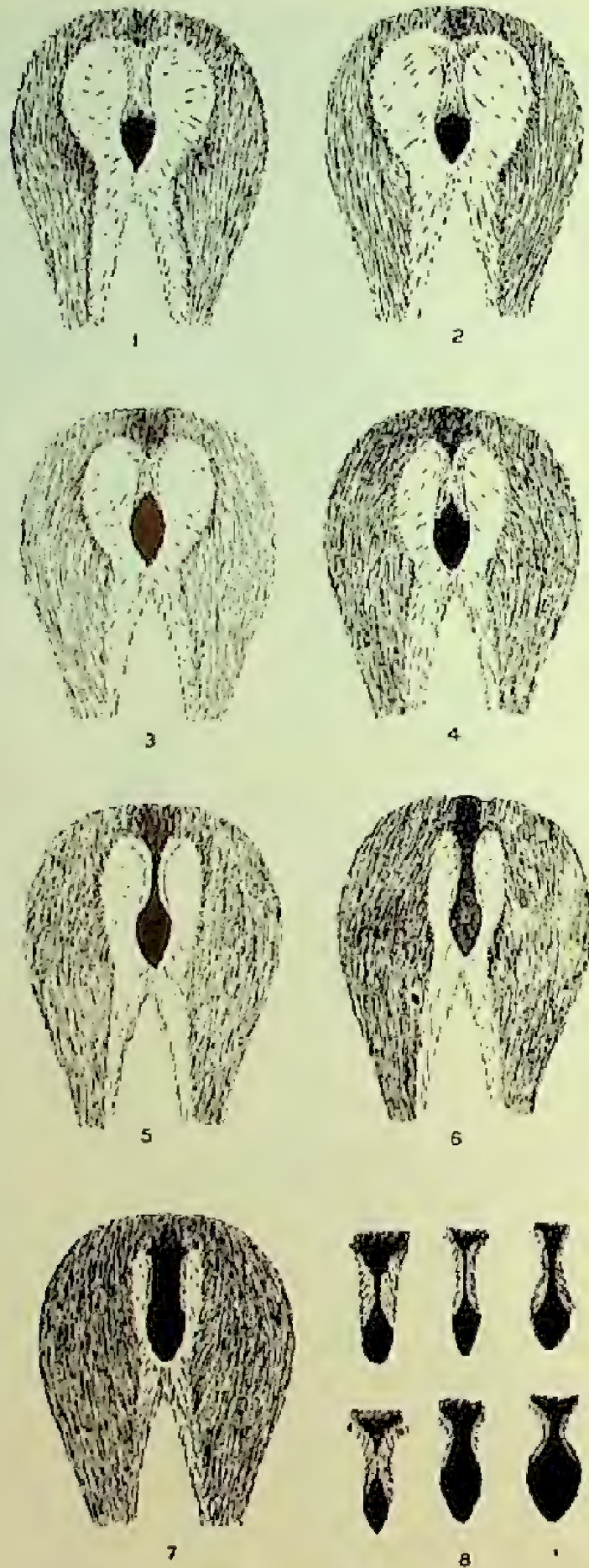


FIG. 66. Rump patches and tails of California deer, illustrating differences between the various subspecies. 1, Rocky Mountain mule deer; 2, burro deer; 3, Inyo mule deer; 4, California mule deer of the southern Sierras; 5, California mule deer from the region between Madera County and Lake Tahoe and in southern Monterey, most of San Luis Obispo and Santa Barbara counties; 6, Southern mule deer; 7, black-tailed deer; 8, various types of tails found in hybrids between mule deer and black-tailed deer.

The following is a tabulation of the results of the studies:

	Total deer	Total bucks	Spike bucks	Does and fawns	Does	Fawns	Ratio bucks to does	Ratio bucks to fawns	Ratio does to fawns
1933-34-----	9,263	1,449	143	7,814	5,690	2,124	1-3.9	1-1.4	2.6-1
1934-35-----	26,473	4,172	207	22,301	14,885	7,416	1-3.5	1-1.8	2-1
1935-36-----	8,928	1,353	125	7,675	5,361	2,214	1-3.9	1-1.6	2.4-1
1936-37-----	21,517	3,904	147	17,613	13,652	3,961	1-3.5	1-1.0	3.4-1
Summary-----	66,181	10,918	622	55,303	39,588	15,715	1-3.62	1-1.44	2.52-1

The above counts were made throughout the winter months. It will be noted that during the four winter seasons, a total of 622 spike bucks was observed. Most of these were seen in the Fall River-Burney region, Shasta County, and in eastern Siskiyou County where there has been considerable crossing of Rocky Mountain mule deer with Columbian black-tailed deer. Even when crossed and recrossed many times, the yearling bucks are generally spikes rather than forked horns, as in the case of the pure-bred Rocky Mountain mule deer yearlings. This is consistently true even though mule deer blood predominates. Normally, one pure-bred yearling Rocky Mountain mule deer out of fifty is a spike. One out of ten is a three-pointer and the rest are forked-horns, although occasionally a four-point yearling is found.

Stokes found in his spring counts that the number of mature deer was about equal to the number of immatures. In a total of nineteen counts there were 283 mature deer and 252 immatures.

The migration of the Rocky Mountain mule deer varies in time and route from the various summer ranges. When deer are migrating they show less caution than at other times. They seem to have one thing in mind and proceed on their way without much regard to safety. This is particularly true during a storm. I am sure that they do little observation ahead on their line of travel.

I stood in the open along the Canby-Klamath Falls Highway, south of Perez, watching deer go by me within thirty yards without any particular attention being paid to me. Even when I moved about in plain sight as they approached, they only turned to one side and went on. They seemed to be more concerned with the weather than they were with human beings standing or walking in their migration route. Two large bucks near the same place attempted to go between two of us but gave it up when we started toward each other. They turned back and moved laterally about two hundred yards and continued on their way northeast.

It seems to make little difference whether the first storm is early in September or late in November, the mule deer start moving when or just before it strikes. They will return part way to the summer range again if the weather becomes mild after an early storm but leave as soon as winter really sets in.

The routes taken are not always the most direct. In fact, a direct route is the exception rather than the rule. Mule deer generally move from one ridge to another rather than cross wide valleys. This method often results in doubling back and has led some observers to become confused concerning the direction of migration routes. This is particularly true in the more level types of habitat where there are only a few knolls and low mountains, or where there are mountains with

valleys between. The region around Bogard, Bridge Creek, Harvey Valley, Poison Lake and Champ's Flat, in Lassen County, is a good example of this type of terrain.

In Lassen County the general trend of migration is toward the southeast, except in the northwestern part of the County, where we find them moving northward into the Pit River Canyon.

In Modoc County, there are four principal winter concentration areas. Deer summering in the Warner Mountains go south into eastern Lassen County and western Nevada. Some winter in Surprise Valley, the upper South Fork and the upper North Fork of the Pit River. Those from the south side of the Devil's Garden go south into the rims of the Pit River Valley and others go northwest toward Tule Lake.

Deer that summer on the northerly side of the Devil's Garden winter from the vicinity of Blue Mountain westward to the Lava Beds region south of Tule Lake depending on the severity of the winter.

The summer herd from north and west of Big Valley splits in winter, some going north to the Lava Beds south of Tule Lake, others

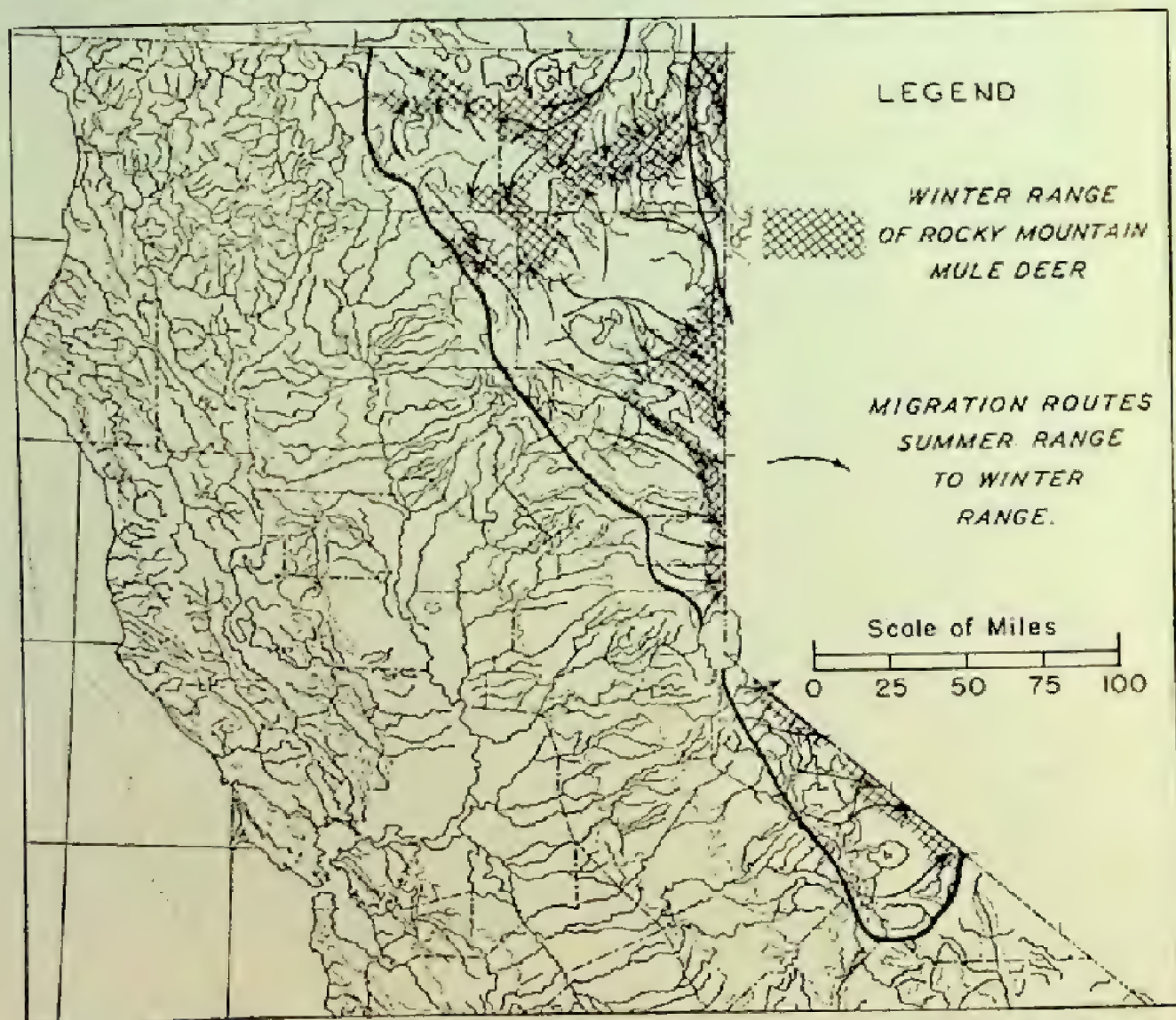


FIG. 67. Migration routes of Rocky Mountain mule deer from the summer range to the winter range.

into Little Hot Springs Valley, Stone Coal Valley, the southwest end of Big Valley Mountain in the vicinity of Muck Valley, and to the lower slopes bordering Big Valley.

The Siskiyou County mule deer may not migrate at all in certain areas. Main concentration areas are near Mount Dome and around Butte Valley on the lower slopes.



FIG. 68. Mule deer range; lightly used in summer, heavily used in winter. Pete's Valley, Lassen County, 1934.

The winter range of the Rocky Mountain mule deer which summer in Plumas County and southwestern Lassen County is along the southwestern side of Honey Lake Valley and in the vicinity of Long Valley.

Those from farther south along the east side of the Sierra Nevada Mountains drift eastward to the desert ranges and even into Nevada. Mono County animals move eastward along the California-Nevada line.

In a few places the Rocky Mountain mule deer winter west of the western boundary of their summer range. Such a place occurs in the Pit River region between Lake Britton and Rock Creek.

Hybrids between the Columbian black-tailed deer and the Rocky Mountain mule deer go in either direction during the fall migration. Some go with the mule deer and some go with the black-tails. Occasionally, they do not seem to be able to make up their minds and remain in places where they have a very difficult time sustaining themselves during the winter. In fact, some have been found wintering on the summer range where the snow is ordinarily very deep.

Generally, the fall migration to the winter range is much more rapid than the spring migration back to the summer range. This latter movement ordinarily follows the receding snow line in a rather leisurely manner.

Many of the larger bucks do not make the entire trip from the winter range to the summer range with the rest of the deer but remain in areas suited to them along the way. They seem to prefer

the more open types of territory where they can grow their antlers without danger of injuring them on brush and dense vegetation. They apparently prefer a rolling type of country with medium height sage brush, scattering junipers and patches of plum or cherry. Mountain mahogany crowned ridges and buttes are favorite places to bed down and feed. The heads of sage brush basins affording an open view of the country below are also used to a considerable degree as bedding and feeding places. When lying down in such locations, they are sometimes very hard to "jump," remaining in their beds even when a person passes within a few feet of them. During the morning, when they are up and feeding, it is generally quite difficult to approach old mule deer bucks. They can spot a person long before a close approach can be made. They keep a basin or two ahead of the intruder and eventually make good their escape. An approach down wind is always extremely difficult, as their sense of smell is apparently quite keen. They do not seem to be as sensitive to sound as the black-tails. At any rate, the sound of talking or rolling stones does not seem to disturb them greatly.

It has been noted many times that a large buck will be found with a small buck especially during the hunting season. Whether this is for protection or because one large buck has difficulty in getting along with another large buck is a controversial point. Perhaps the younger buck is used as a decoy. The older bucks that are found with does or small bucks ordinarily wait for the other deer to "jump" before they attempt to make a get-away, and even then they generally take an entirely different route from that taken by the others.



FIG. 69. Lightly grazed mule deer winter range, near Doyle, Lassen County, March, 1935.

An old mule deer is seldom caught "napping," especially by the inexperienced hunter. They are generally found in a situation where at least one avenue of escape is available. This gives the hunter little chance to get a shot. This is one reason mule deer bucks live long enough to become large. After the hunting season, they may

become very bold and stand along the roads and trails displaying little of the instinct of self-preservation.

By this time the rut is generally in full swing. Since the does have little fear, the bucks must stay with them or take the chance of



FIG. 70. Heavily grazed mule deer winter range, near Doyle, Lassen County, March, 1935.

other bucks usurping the does in their absence. Occasionally, a buck is encountered during the rutting season that makes a show of temper toward a human being, but I doubt if one would actually attack. He will stand his ground with little evident fear, the hair standing on end and a "kink" in his neck, watching the intruder out of the corner of his eyes and occasionally shaking his head and blowing through his nostrils in a defiant manner. In some instances, this show of defiance can be increased by some sidling and bluffing on the part of the observer. I have never carried it too far, having remained close to the automobile, so I am unable to say just how far it would be possible to go before a buck would either attack or depart. I believe that he would finally move away.

During the rut, the bucks have terrific battles that occasionally last for a considerable time and extend over a rather large area. Bucks that are evenly matched in size and strength fight until almost exhausted before one or the other finally becomes the victor. The antlers are used almost exclusively in the battles during the rutting season, whereas at most other times, the front feet are used more as weapons. When one buck is finally victorious, the defeated one makes off to other fields and the victor returns to his group of does. Sometimes he chases the loser for a short distance, but more often he simply stands and watches him depart.

When two large bucks are fighting, small bucks will sometimes make the best of the opportunity to mingle with the does. Two small bucks can make life miserable for a large one. While he is chasing one away, the other will join the does. When he dashes back and pursues the interloper, the other small buck returns. This may con-

tinue until the older buck becomes exhausted. When two fairly large bucks appear on the scene where one buck has a harem, a change of herd buck sometimes takes place. The original buck becomes tired from chasing first one and then the other, and finally one of them challenges him to a fight and is often victorious. The successor, in turn, may be challenged by the third and, because of fatigue, may lose out to the fresher buck. As a rule, bucks on a range where there is little migration seem to know their superiors and battles are rare, but in areas where new bucks are coming in from the outside, fights for possession of groups of does are quite common. Occasionally, the antlers of fighting bucks become interlocked, bringing death to both combatants. Sometimes these interlocked heads are picked up by hunters and range riders in the areas where deer rut.

During the rutting season, stray bucks are seen wandering through the country with their heads down following the scent of other deer. Generally, these bucks have no harems of their own, but go from one group to another until they are able to find a buck that can be overpowered or to sneak into a group of does while the herd buck is contending with another.

It is rare to find one buck quarreling with another when no does are present. The smaller bucks do not try to hamper the larger ones in their movements and will follow them practically everywhere, even though it be in the rutting season. They will occasionally stand for considerable periods and chew ticks on one another. However, should does be encountered at this season, the young bucks ordinarily give ground.

Does ordinarily show little or no interest in the quarrels of the contending bucks and seem to show little preference for one buck or another. I did, however, see one battle between two bucks that created quite a general disturbance in the harem, even some downright quarreling. I did not see the beginning of the fight, so I do not know if it was caused by the meeting of two entirely different groups of deer in their wanderings, or by one buck trying to usurp the harem of another. I believe it was probably the former. Does are only fairly tolerant of each other at any season, and occasionally one will strike a lesser animal if the opportunity arises. Their front feet are very effective weapons. In spite of the fact that large numbers of does and fawns are often seen together, the "bosses" are apparently well known and respected at all times.

Stokes, in the Canby area of Modoc County, observed that most of the bucks' necks were losing their swelling by December 27, and by January 11 all bucks' necks were again of normal size.

The Rocky Mountain mule deer have fewer enemies than the black-tail. Throughout most of the range of the former in California, the mountain lion is uncommon or rare. The mountain coyote is fairly numerous over most of its range and is probably its principal enemy excepting man. Undoubtedly, coyotes kill a number of fawns and harry the deer on the winter range, especially where the snow is deep. I watched a large mountain coyote pursue a small mule deer doe for several miles over the lava and tableland region north of Courtright's in Modoc County. This coyote did not rush the doe but kept up a steady, even pace about fifty yards behind her for a zig-zag circuitous

run of at least four miles. After pursuing the doe for that distance, he had not gained appreciably, but I feel convinced that had I not interrupted the chase with a rifle bullet, he would have finally worn her out and captured her. She was so tired after I had killed the coyote, that she did not go more than a half mile before lying down. Other deer that were in the immediate vicinity made no effort to assist the doe, nor did she stop in a group of some fifty when the coyote pursued her directly through the middle of them. They simply separated and ran a short way and stood watching the chase. At no time was there any great consternation shown by the band—only mild interest. An adult mule deer on good footing would certainly be more than a match for one mountain coyote, but several would probably be able to drag one down. In fairly deep snow, the advantage would certainly be with the lighter weight coyote.

Stokes saw no signs of coyotes chasing deer in winter, but found one dead fawn in the spring that he was positive coyotes had killed.



FIG. 71. Mule deer infected with *Actinomyces necrophorus*, or so-called "calf diphtheria," at Whitehorse Reservoir, Modoc County, 1931.

The only winter kills that he thought might be attributed to coyotes were in boggy flats and against fences.

Disease has taken considerable toll of mule deer in Modoc, Siskiyou, Lassen and Shasta counties. Calf diphtheria, caused by the organism *Actinomyces necrophorus*, has taken the greatest number of animals. The bacillus is found in many of the stagnant ponds and small lakes in that area. Apparently, it has been introduced into the region by sheep and cattle.

Internal parasites are a factor in the existence of mule deer, but they are apparently not so heavily infested as black-tail in some parts of their range. Common endoparasites are lung worms, round worms and occasionally tape worms.

The deer bot fly, *Cephenomia pratti*, is found throughout the entire State and is the cause of much suffering and unrest among mule deer.

The loss from this pest must be considerable. Stokes found two deer that had to be destroyed because they were blinded by bot fly larvae. One was a doe, the other a buck (spike and fork). The antlers of the latter were still partially covered with velvet in March.

Ticks of several different species are quite numerous on deer, but I doubt that they are the independent cause of many losses. However, if the animals were already weakened, these parasites might lower the vitality of the host enough to bring death, especially under the severe weather conditions that sometimes prevail in the Modoc and Lassen region. Deer are adept at destroying ticks in an odd manner. They will bite ticks on each other, taking turns in chewing the pests. They nip them off and generally chew and swallow them. This mutual aid in defense against these parasites is practiced by all ages and sexes. At least two different kinds of deer tick flies are also found in the mule deer area, but little is known of their effect on the general health of the animals in the wild.

The heavy concentrations of deer on the winter ranges are potential foci for outbreaks of disease, but on the whole little evidence of such outbreaks has come to our attention. The principal causes of losses under these conditions have been poachers, railroad trains, automobiles, wire fences, starvation, predators, and death due to pneumonia resulting from being chased by over-zealous photographers and sight-seers. In this latter case the deer become overheated, and when they lie down in the snow to rest, they are apt to take pneumonia.

The loss from automobiles and trains can not be minimized. All persons driving into deer country at night should be on the alert for light-blinded deer that often dash in front of cars, resulting in death for the deer and considerable damage to the automobile. The annual loss due to this cause in the Modoc, Lassen, Siskiyou, Shasta and Plumas areas runs into several hundred animals, and the damage to automobiles into several thousands of dollars.

The destruction of deer by trains is more difficult to avoid, especially when the snow is deep. At that time, the only shallow snow is generally on the right-of-way where the snow plows have removed the snow. It is natural, of course, that the deer try to find shallow snow, and eventually they get into the cuts made by the snow plows. Here they are blinded by the headlights or confused by the whistle of the oncoming train and dash to their deaths under its wheels or against right-of-way fences. Many deer are killed in this manner between Klamath Falls and Alturas and along the Western Pacific Railroad in the vicinity of Doyle and Long Valley in Lassen County.

I have noted that mule deer try to stay out of snow that is more than knee deep whenever possible. When deeper snow is encountered, it impedes progress and makes the escape from enemies more difficult. The knees drag badly and in order to make any speed it is necessary for the deer to jump rather than trot or walk. Deep, boggy mud also hampers their activities considerably, and I have found that they try to keep clear of such areas, especially in winter. In summer, they seem to take delight in wading in muddy bogs around springs in search of plants and water.

Mule deer fawns are difficult to find when they are very young because the old does hide them well, and instinct seems to tell the young

not to move. Their pelage blends so well with their surroundings that they are difficult to see even when one is almost upon them. They remain absolutely immobile with their eyes ordinarily closed or nearly so. The ears are flattened back along the neck, and the legs are tucked under their bodies in such a manner that should they actually be discovered, one bounce will put them on their way. They are able runners even when small. It is generally agreed that fawns have little or no body scent, for it has been noted that keen-nosed animals such as dogs and coyotes often pass close to fawns without scenting them at all. Ordinarily, fawns are weaned by the doe when two or three months old. However, this does not mean that she leaves them, for after they are weaned she shows as much solicitude for their safety as before, especially as winter approaches. It is not at all uncommon to see year-old fawns and new-born fawns with the same mother. In this case, the actual severance of domestic relationship does not take place until the young are fifteen or sixteen months old.

Stokes found the deer quite noisy from February 24 to February 27, 1938. The days were warm and sunny and the deer not very active. As they walked around and grazed, the fawns kept blatting, the sound resembling a mewling "meer" or "beer" in a high pitch. Occasionally a mature doe would "blat" in a much lower pitch. The most noise was made during the middle of the day, when two-thirds of the mature deer were bedded down. The fawns could be heard at a distance of 300 yards.

Estimates of speed attained by mule deer when running vary widely. By actually timing individuals, I have found that many of these estimates were far from accurate. The highest speed that I have been able to force out of a mule deer is 38 miles an hour. This animal was pursued on the surface of Mosquito Lake flat in Modoc County. After the first short burst of speed, the animal dropped down to about 23 miles an hour and became badly winded after a chase of less than a mile. This rather large four-point buck was forced to remain on the lake bed by maneuvering of the car. When he finally entered the timber at the edge of the flat, he went only about 300 yards before lying down under a small pine.

The results of other tests made in different places and on different sized individuals showed that this record is about top speed for this species. When allowed to choose their own gait, they are able to travel at about 20 miles an hour for a considerable period of time. In rough, broken country the mule deer is at its best. Here the long, high bounds send the animal over the rocks and brush at a much faster pace than the average running animal can make through and around these obstructions. In going down or up lava rim-rocks the mule deer makes remarkable speed. The longest bounds are generally made when going downhill or leaping across ditches and gullies. I have measured two flat jumps across washes that were $19\frac{1}{2}$ and $23\frac{1}{4}$ feet, respectively. A downhill bound on a seven per cent slope measured 28 feet and 7 inches between the forward hind foot track of one set of tracks and the rear front foot track of the next set of tracks. When rattled, mule deer sometimes bound wildly without making any progress. I have seen bucks, when hunters were shooting at them, bounce up and down for

some time before finally gathering their faculties and striking out in a definite direction.

The caution displayed by mule deer when the presence of an enemy in the near vicinity is suspected, has been demonstrated to me many times. In one instance, an old doe and three smaller deer were observed southwest of Terno, Lassen County, just below a lava rim. I was about a mile away down wind when I saw them and was able to sneak around to the top of the rim above them and about thirty yards distant. To attain the rim, I had to cross the wind, and apparently a slight whiff of my scent was borne to the doe. Fortunately, I was able to slip out to the rim's edge and, without being observed, to watch the animals below me. Apparently, the doe was not able to tell whether my scent had come to her from the left or right side. She moved first one way and then the other with a peculiar, slow, mincing gait and tested the wind continuously, as I could see the end of her nose moving rapidly. She could not decide whether to go one way or the other around the rocks and did not want to go downhill since that would force her out into the open where there was no cover.

From where I was located directly above her, it was apparent that my scent was passing over her at a considerable height. Finally she slipped into some mahoganies with the rest of the deer and stood perfectly still to await further developments. They all stood "frozen" for about ten minutes, during which I noted that each animal was watching a different direction. I picked up a rock about the size of my fist and threw it, from out of sight behind the rim, so it would land almost in the middle of the group. As it crashed through a mahogany to the ground, each of the four animals ran in the direction which it was facing and stopped after about five or six jumps. After some time, one of the smaller deer started to move and went back to the point where the rock had landed. It moved with extreme caution, raising and lowering its head many times in an apparent effort to see to better advantage. When it had finally reached the point where the rock had fallen, it examined the hole the rock had made in the fairly loose dirt, sniffing loud enough so that I could hear it even at thirty yards distance. When the rock was finally sniffed, the animal broke into a run, and the whole group went around the hill to the north without further hesitation. It seemed apparent to me that the deer had detected the human scent on the rock and had taken immediate alarm, the others following suit. Without testing the wind further, they had departed the quickest way, into the mahoganies, around the hill and out of sight.

Another time, two relatively large bucks were seen coming toward me in a leisurely manner over a ridge about two hundred yards away. As they moved along, they stopped and fed on bitter brush. Coming down the hill, they both seemed to sense that something was wrong in the bottom of the gulch. First one stopped and looked and then the other. Finally, they both stopped and scanned the bottom thoroughly from one end to the other. They did not see me, even though I was not hidden behind any object, having stationed myself among some scattered lava rocks, none of which was as large as my body.

When they finally decided to come down into the bottom of the gulch, they did so very cautiously, holding their heads low and walking

with the peculiar, mincing, jerky gait that I have noted at other times when these animals are nervous. Upon reaching the dry stream bed and starting across, the leader walked directly into my scent which produced startling results. With a sudden snort, he whirled to the side and went over a rim-rock on the second jump. The second one apparently had not scented me and remained standing motionless for a second or two. He then sneaked off at a crouching, low, fast trot. He did not go over the rim out of sight, but around the slope on top of the rim. I am convinced that he did not smell me and did not know why the other buck had made such a wild departure.

Another very large buck was observed through eight-power glasses standing alone under a small, low-hanging juniper about five hundred yards away, calmly chewing his cud. He had a tremendously swollen neck, indicating that the rutting season was at its height. He did



FIG. 72. Rocky mountain mule deer buck in forested range.

not see me as I walked out on the open ridge across the canyon from him, so I slipped back out of sight and worked around down wind and behind him. When I climbed to a rim-rock about ninety yards below and cautiously slipped my head up over the edge, I found that he was lying down under the juniper.

After I had watched him for a few moments, he got up and pawed some small rocks out of his bed, turned around two complete turns and tried the bed again. He did this three times before he seemed to be satisfied. After lying quietly for about one minute following the last digging job, he began to chew his cud again. He chewed three cuds an average of 33 chews to a cud (29, 34, 37) swallowing each cud rather slowly. As he started to chew the fourth cud, he stopped on the sixth or seventh chew and gazed out above and to the left of me. I cautiously turned my head to see what he had discerned, but failed

to see anything. I slowly turned my head back and watched him. He made no move, nor did he chew further on his cud which he finally swallowed. He still continued to look across the canyon and finally got up and stood for some time gazing in the same direction. He shook his head a couple of times and started walking rapidly along an old deer trail leading around the slope and down into the canyon. He trotted across the bed of the gulch and for some distance up on the other side. Suddenly he stopped and turned his head toward me, gazing intently in my direction for about twenty seconds. He then started walking up the slope, but looked back toward me several times without, however, showing any fright. He went into a small stand of junipers and almost immediately a three-point buck went out the lower side of the patch in hurried retreat.

After some minutes the larger buck strolled out into the open accompanied by four does. He did not seem to be greatly interested in them and finally went off alone, whereupon the small buck came back up the hill and rejoined the does. The large buck came almost directly toward me, apparently forgetting that he had discerned something out of the way on the point where I was located. He finally dropped down and started to cross the canyon below me, but walking into my scent, he stopped, looked in my direction for a few moments, and then turned and dashed hurriedly out of sight around the hill.

The other deer heard him running and made off up the hill into some mahogany brush near its top. A few moments after they had disappeared, three more deer that I had not seen came trotting from the direction in which the large buck had been headed when he had gotten my scent. They were almost directly behind me when I heard them approaching. I remained quiet, expecting them to get my scent at any moment, but they came parallel to it and passed within twenty feet without seeing me.

They stopped at about forty feet and stood gazing first one way and then another. Their ears swung back and forth in an attempt to pick up some sound that might give them a clue as to the whereabouts of the danger. I whistled softly in a high pitch and instantly every head turned directly toward me. They did not run but stood gazing toward me intently. All they could possibly see of me was my head, and if they actually distinguished any part of me, they certainly showed no sign of it because they finally began looking off to greater distances. I then whistled very loud and shrill, whereupon each one of them made a jump or two and stopped to take a look. Satisfied that something was amiss in that particular spot, they all started trotting and jumping up the hill and out of sight. This experience showed me that unless a good view of an enemy is secured or the scent definitely analyzed, it takes considerable noise to frighten mule deer badly enough to make them run away.

Noises of a man walking through the brush will cause mule deer to slip away or even run. I believe that the difference in the sequence of the tread between man and deer is distinguishable to them.

I walked out on a rock in the scattering sage brush south of Terno and stood for some time looking out over the country spread before me. As I stepped off the rock on the lower side, I was almost bowled

over by a three-point buck that had been bedded down almost directly under my feet and not more than two feet from the toes of my shoes. Whether he was asleep or had decided to remain "frozen" in the hope that I would not see him is a question, but the fact remains that I had apparently caught him entirely unawares and was so close that had I been a lion or a coyote, he would have been at a great disadvantage.

One of the wildest turmoils of deer that I ever witnessed was in Modoc County near Perez on a small rim of lava. I was sitting in a crack in the rocks watching some deer in a flat about seventy-five yards away and trying to determine their reactions to extreme cold (—29 degrees F.), when suddenly I heard a noise behind me in some rocks and brush. Immediately, I was almost engulfed by a large number of deer that were running pell-mell from something that had frightened them at some distance east of where I was located. I rose to my feet to avoid being trampled, and the effect was like an electric shock. Each deer began to bounce, failing to make headway. It was several moments before they collected their wits and made off. There were several collisions during the commotion and at least two deer were knocked off their feet or fell down from fright. I was able to see that the hair stood on end in the case of some of the closer ones, and I heard several snorts of fright. These deer did not run very far, however, before they stopped and looked back.

Near a small lava butte in the vicinity of Horse Lake in Lassen County, I saw about fifteen does and fawns running over a ridge at least a mile from where I was standing. I concluded that I had frightened them from some point near me and had not seen them until they had crossed the intervening canyon. While I was standing looking in the general direction of their departure, I was surprised to see them coming around the end of a point headed nearly straight for my position. They came on and ran up the swale just below where I was standing. I am undecided whether I startled them or if something else frightened them and started them on their circuitous route. At any rate, they showed no signs of having seen or scented me at any time during their flight.

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A REPORT OF PREDATORY ANIMAL CONTROL ACTIVITIES FOR THE YEAR ENDING JUNE 30, 1939¹

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California Division of Fish and Game*

The month of June, 1939 brought to a close the third year of the new trapping program of the Bureau of Game Conservation. The results are gratifying to those who have placed their faith in the group of young men that constitutes the Bureau's corps of trappers. Trained by our supervising personnel, they are rapidly justifying the confidence that has been placed in them and in the system. As a perusal of table 1 will show, there has been a substantial increase in the take of coyotes and bobcats each year for the last three. As the trappers continue to gain experience and become better acquainted with their districts, we shall expect even better results.

Division of Fish and Game trappers have devoted in the past most of their time to the control of predators within and immediately adjacent to game refuges, and have dealt secondarily with other game areas in which predators have not been controlled by any other agency. This policy will be continued, since the trapping force is still not large enough to adequately take care of the refuge areas alone, much less the balance of the game country in California.

A fine spirit of cooperation continues to exist between the Division of Fish and Game and the U. S. Bureau of Biological Survey, the agency that directs a force of some sixty trappers that are paid from federal, state, and county funds, and operates primarily within areas where cattle, sheep and other domestic animals are produced. Through this cooperation, the possibility of conflict and duplication of effort has been almost entirely eliminated, and both agencies have been able to better serve the interests of wild life and the live stock industry.

For the past three years, the U. S. Forest Service, in cooperation with the U. S. Bureau of Biological Survey and the California Division of Fish and Game, has been conducting a study of coyote-deer relationship within the Los Padres National Forest in Santa Barbara County. The Division of Fish and Game has assigned one trapper to this study and will continue to cooperate actively until it has been concluded. The study, which was begun at the request of the Santa Barbara County Fish and Game Protective Association, will determine once and for all the role played by the coyote within the range of the southern California mule deer.

There is still much to be learned concerning the food habits of the bobcat, house cat, fox, and other small predators. The trappers

¹Submitted for publication, February, 1940.

preserve the stomachs of these species and ship them to the Food Habits Research Laboratory of the U. S. Bureau of Biological Survey. There the stomach contents are carefully and expertly analyzed. Samples of the contents are retained in the laboratory for reference in the event that there is any question concerning the identification of the various items of diet. The Division is particularly anxious to secure analyses of as many bobcat stomachs as possible since there has been, and still is, some question as to the advisability of concentrating trapping effort on this species.



FIG. 73. Division of Fish and Game trappers are well trained and properly equipped.

During the past year the Bureau of Game Conservation has aided in the dissemination among sportsmen and farmers of information concerning trapping methods and the preparation of baits and scents. One trapper has been assigned to the California Junior Game Patrol and has given individual and group instruction to members of many of the troops. The take of the Junior Patrol members is reported to the Bureau of Game Conservation each month.

To supplement table 1 which shows the predator catch by counties for the last three years, there is included a set of tables showing the catch by months for the same period. In these tables the total number of trapping days, the miles of trap line, and the number of

sets made during each month have been indicated in addition to the catch.

During the past year the Bureau of Game Conservation has maintained a staff of twenty trappers, including four supervisors. Each of the supervising trappers, with one exception, maintains his own trap line in addition to taking care of his supervisory duties. The supervising trapper must maintain contact with the trappers assigned to him in order to make sure they are properly located. He collects and counts the predator scalps which are offered by the trappers as



FIG. 74. A good spot for a "set." Coyotes frequently travel along little used roads.

proof of take and sees to it that the scalps are destroyed in the presence of witnesses. Other duties of the supervisor include the investigation of all complaints of depredations reported to him, the maintenance of contact with other predatory animal control agencies within his district, and the instruction of young men assigned to him for training. It has been stated before, and it should be repeated, that our entire trapping force is made up of men who have been trained in predatory animal control methods since the inception of the new trapping program in 1936. The writer can think of only one of the entire crew

who had had the benefit of actual experience on the trap line before he became an employee of the Division.

And now, a few words concerning lion hunting—an activity that this Division has carried on for many years both by the employment of expert lion hunters and the payment of bounties. The number of permanent lion hunters was increased to four during the past year by the appointment of a hunter to take care of southern California and the assignment of another to northwestern California. This man will take care of the counties of Siskiyou, Trinity, Shasta, Humboldt and Del Norte, primarily. Of the total of approximately 250 lions that



FIG. 75. Another good place for a "set," at the intersection of a road and a trail.

are taken in California each year, approximately one-fourth are taken by State hunters. The balance is taken by 100 odd men who hunt, some regularly and others occasionally, for the bounty, or incidentally by deer hunters.

In bringing this report to a close, the writer wishes to call attention to the fact that no mention has been made of the cost of trapping. To be brief, the Division's predatory animal control program, including both trapping and lion hunting, costs approximately \$60,000 per year. To go any further and analyze the expenditure on a cost-per-animal basis would be entirely unfair. There is no more justification for measuring the efficiency of a trapper with the cost-per-coyote yard-

stick than by judging the capabilities of the law enforcement officer by the cost of each case that he makes. The success of our predatory animal control program will depend on results, not costs. It would be very easy to so locate our trappers that the average take would be much greater than it is today. Instead, we are trying to place our men in areas where they will get results, and we do not feel that a low catch record is necessarily an indication that results are not being obtained. In fact, in most cases a low catch record means that the trapper is doing his job well. To "skim off the cream" and keep moving is not sound predatory animal control. It is not, in fact, control in any sense of the word. And, therein lies the difference between the paid hunter and trapper and the bounty systems. The bounty hunter can not afford to stay with the job until it is finished. He is a "skimmer" who leaves in his wake a plentiful supply of seed.

The last coyote to be taken in California will cost a great deal, and the monthly trapping record of the man who takes that last coyote will probably be regarded as unusually low by the members of the cost-per-coyote school. Just one measly coyote! But that will be a *few* years from now at least.

TABLE 1
Predatory Animal Catch by Counties

	July 1, 1936, to June 30, 1937				July 1, 1937, to June 30, 1938				July 1, 1938, to June 30, 1939				Grand total
	Coyote	Bobcat	Other predators	Total	Coyote	Bobcat	Other predators	Total	Coyote	Bobcat	Other predators	Total	
Amador.....									22	3	4	29	29
Butte.....	3		2	5	26	15	200	241					246
El Dorado.....	13		5	18	9	2	9	20					38
Fresno.....					62	44	136	242	140	48	87	275	517
Glenn.....	13	19	41	73	23	35	5	63					136
Humboldt.....	24	78	38	140	1	150	67	218	4	155	117	276	634
Inyo.....	16		34	50	170	8	44	222	21	5		26	298
Kern.....	11	10		21	100	78	8	186	520	105	18	643	850
Lake.....									13	10	19	42	42
Lassen.....	62	4	26	92	52	4	7	63	88	7	22	117	272
Los Angeles.....					28	1	9	38	114	25	80	219	257
Mariposa.....	26	4		30	28	4	37	69	39	8	42	89	188
Mendocino.....									1	8	17	26	26
Merced.....					16		71	87					87
Modoc.....	4	2	2	8	53	7	16	76	68	3	26	97	181
Mono.....									84	3		87	87
Monterey.....	7	5	11	23	66	61	54	181	250	257	99	606	810
Napa.....					14	55	31	100	18	44	50	112	212
Nevada.....									74	14	203	291	291
Placer.....									20	6	47	73	73
Plumas.....					4		3	7	27	1		28	35
Riverside.....	16	3	3	22	25	10	33	68	248	93	147	488	578
San Benito.....	273	84	123	480	23	7	18	48	311	142	176	629	1,157
San Bernardino.....	32	4	21	57	245	17	60	322	193	38	78	309	688
San Diego.....	45	7	71	123	185	57	151	393	48	11	30	89	605
San Luis Obispo.....	57	45	54	156	28	6	51	85					241
San Mateo.....									1	12	11	24	24
Santa Barbara.....					93	19	109	221	140	50	46	236	457
Santa Clara.....					69	23	46	138		1		1	139
Shasta.....	4	4		8	16	10	6	32	88	21	65	174	214
Siskiyou.....					123	24	46	193	32	7	26	65	258
Stanislaus.....									15	4		22	22
Trinity.....	71	37	126	234					23	14	29	66	300
Tulare.....	283	103	18	404	192	119	103	414	11	9	88	108	926
Tuolumne.....									50	10	7	67	97
Ventura.....	29	17	48	94	6	2	1	9	93	9	45	147	250
Totals.....	980	426	623	2,038	1,657	758	1,321	3,736	2,789	1,123	1,579	5,491	11,255

TABLE 2

Predatory Animal Catch by Months—July 1, 1936, to June 30, 1937

Month	Days	Miles	Sets	Coyote	Bobcat	Others	Total
July.....	88	2,319	4,632	33	2	18	53
August.....	239	4,221	3,969	99	15	10	124
September.....	239	5,683	5,495	124	31	23	178
October.....	215	5,211	4,516	74	22	39	135
November.....	210	6,178	5,406	74	29	23	126
December.....	217	5,815	4,909	95	37	17	149
January.....	185	4,816	4,778	58	9	36	103
February.....	150	2,907	6,873	23	25	95	143
March.....	305	3,516	6,615	56	54	83	193
April.....	504	6,793	10,391	120	59	93	269
May.....	543	9,572	13,651	142	78	104	324
June.....	391	10,929	12,146	91	68	82	241
Totals.....	3,286	67,960	86,381	989	426	623	2,038

TABLE 3

Predatory Animal Catch by Months—July 1, 1937, to June 30, 1938

Month	Days	Miles	Sets	Coyote	Bobcat	Others	Total
July.....	421	10,648	13,754	107	56	103	266
August.....	420	12,302	15,877	196	62	96	354
September.....	358	8,745	11,610	183	40	134	357
October.....	411	7,061	12,935	201	65	163	429
November.....	450	10,667	17,066	170	73	128	371
December.....	498	13,562	17,015	177	63	98	338
January.....	588	14,498	21,948	182	82	207	471
February.....	542	14,389	18,701	96	57	79	232
March.....	312	10,091	11,317	43	37	52	132
April.....	288	9,655	11,756	59	55	77	191
May.....	337	9,285	10,919	94	81	63	238
June.....	393	15,793	16,508	149	87	121	357
Totals.....	5,018	136,696	179,406	1,657	758	1,321	3,736

TABLE 4

Predatory Animal Catch by Months—July 1, 1938, to June 30, 1939

Month	Days	Miles	Sets	Coyote	Bobcat	Others	Total
July.....	494	22,451	23,171	227	84	112	423
August.....	492	23,654	24,001	358	58	68	484
September.....	372	16,814	19,253	264	56	125	445
October.....	347	14,888	17,957	258	79	117	454
November.....	353	14,123	17,558	238	105	116	459
December.....	432	16,312	18,389	192	74	121	387
January.....	490	19,040	23,093	206	127	127	520
February.....	421	17,734	23,426	224	105	166	495
March.....	485	17,846	23,741	215	100	124	439
April.....	422	16,506	18,506	179	104	110	393
May.....	456	21,798	22,413	163	134	179	476
June.....	474	19,286	24,578	205	97	214	516
Totals.....	5,238	220,452	256,086	2,789	1,123	1,579	5,491



FIG. 76. Dr. Joseph Grinnell. Photograph reproduced through courtesy of Mrs. Grinnell.

DR. JOSEPH GRINNELL

February 27, 1877-May 29, 1939

Dr. Joseph Grinnell was born on February 27, 1877, at the Kiowa, Comanche and Wichita Indian Agency, forty miles from Old Fort Sill, Oklahoma. He was the son of the Agency physician. He came to California with his parents in 1885 and received his A.B. degree at Throop Polytechnic Institute, now the California Institute of Technology. He was an assistant instructor there during 1897 and 1898, and in 1900 he became an assistant embryologist at the Hopkins Marine Station of Stanford University. He received his A.M. at Stanford in 1901 and instructed in ornithology at Stanford from 1901 to 1903, during which period he also was an instructor at Palo Alto High School. He returned to Throop as an instructor in 1903, which position he retained until 1905, at which time he received his professorship at that institution where he served until 1908.

In 1908 he was appointed Director of the then new Museum of Vertebrate Zoology at the University of California in Berkeley, in which capacity he served until his death.

He received his doctorate degree at Stanford University in 1913 and immediately became an assistant professor of zoology at the University of California. In 1917 he was appointed an associate professor and in 1920 a full professor at the same institution.

He was a fellow in the American Academy of Arts and Sciences; fellow in the California Academy of Sciences and its vice president during 1934-1937; honorary member of the Nebraska Ornithological Union, the Biological Society of Washington and the Washington Academy. He was a corresponding member of the Academy of Natural Sciences of Philadelphia, and a former member of the Zoological Society of London. He was vice president of the Society of Mammalogists in 1935-1937 and its president in 1937, and also vice president of the Ecological Society in 1932. He was a charter member of the Cooper Ornithological Club and held most of its offices at one time or another. He was President of its Board of Governors at the time of his passing. He served gratis as the editor of "Condor," the official organ of the Cooper Ornithological Club, from 1906 throughout the rest of his life. Dr. Grinnell was the mainstay in the Cooper Ornithological Club from its organization to the time of his death. It was largely through his efforts that the Club survived its many trying periods. Even through the depression years, the quality of the "Condor" maintained its high standard mainly through the unwavering faith and energy of its editor.

The loss of Dr. Grinnell was a blow felt by his associates, friends, co-workers and fellow scientists, not only locally but nationally and internationally. His numerous publications are well known and studied in many parts of the world by those who did not know the man personally but knew him only as a great scientist.

His friends were legion and represented not only scientists but those in all walks of life, including ranchers, trappers, hunters, amateur ornithologists, game wardens, teachers, the men of money, and the poor. All felt the same toward this quiet, learned man, who had the faculty of being the student as well as the teacher. In other words he was a great listener who analyzed his information thoroughly. His power of reasoning and his vast knowledge as well as his ability to convey to others what he knew himself, made him a great teacher.

He was so honest himself that he could not believe dishonesty in anyone. He often considered dishonesty in others as an error or a mistake in judgment.

Dr. Grinnell's interests were so diversified in his chosen field of zoology that to say he specialized in any one particular branch of this study would be an injustice. He worked on taxonomy, geographic distribution, economic zoology and many other zoological subjects.

My first contacts with him were in 1915 on the preparatory field work for the book, "Animal Life in the Yosemite." Through all the years following, I went to him for advice on many subjects pertaining to bird and animal work. This was always freely given and of the highest value to me. His assistance to budding young zoologists was one of his outstanding qualities and one that made him respected by all, old and young alike.

His advice and criticism on many phases of fish and game conservation work were asked by the California Division of Fish and Game. His advice was good and his criticisms were definite and severe, but personal feelings never entered into the controversy. Others of the Division as well as myself have had long arguments on various subjects but I never knew of one argument, no matter how heated, that ever resulted in the lessening of his friendship toward the other party. Very often he would take the opposite side of the discussion, against his own judgment, in order to have the other person bring out every angle of the subject in question for full consideration.

Dr. Grinnell's knowledge of birds and animals in California and the West was as complete as one person could possibly be capable of assimilating. He was as interested in a small mouse from Death Valley as in a Roosevelt elk from Humboldt County. His study of distribution of both birds and mammals was comprehensive and his publications on this phase are always considered the authority on the subject. His early days carried him far afield, Alaska in particular.

He was never one to waste words but was never too busy to stop his labors for an informal chat on recent happenings in fish and game work or recent observations on birds and animals.

On trips into the field there was no finer companion. Always genial and pleasant he could be depended upon for his part and more in all camp activities, including the added accomplishment of being an excellent cook. I have seen him under various disagreeable conditions and still he was always the same, with a bright, optimistic outlook.

As a worker he was always doing more than his share. In skinning bird or mammal specimens, it seemed that no matter how rapidly one worked, Dr. Grinnell was always ahead when the day's work was over. Many nights we worked until 11 or 12 o'clock skinning specimens and

then out and underway in the field shortly after daylight the next morning.

His notebooks were always used as a model by others, for his word pictures of observations were descriptively excellent. He is the author of many volumes of notebooks in the Museum of Vertebrate Zoology archives. Nothing observed, however unimportant at the time, was ever considered unworthy of notebook space. He once told me, "If it's worth observing, it is worth writing down."

Dr. Grinnell's museum specimens were well prepared and the data accompanying them, both on the tag and in the notebook, were meticulously correct, and he instilled this accuracy into all of his associates. I remember, he once said, "Be sure you have number, date, locality, county, state, elevation, sex, age, the name of the collector on the tag, because any one of these when left out reduces the scientific value of the specimen a like amount." His errors, human or mechanical, were few and far between as is evidenced by his specimen data and publications. His editorial knowledge was demonstrated by his own excellent publications as well as those he edited.

As a teacher, one need only to look at the younger men scattered through our schools, State and Federal positions to see the fruits of his labors. His courses were always in demand because he endeavored to bring in the practical as well as the theoretical aspects of the subjects.

Such was the life of a great man of science, who never was too busy to encourage any person in quest of knowledge. The twenty-four years I knew him seemed but a fleeting moment and far too few.—
Donald D. McLean, Bureau of Game Conservation, California Division of Fish and Game.

EDITORIALS AND NOTES

TWENTY-FIVE YEARS AGO IN "CALIFORNIA FISH AND GAME"

Twenty-five years ago, the tule elk of California, once unbelievably numerous, had been reduced to a pitiful handful. In an article in the April, 1915, issue of "California Fish and Game," Barton Warren Evermann describes the former abundance and the downfall of the elk. Due to the protection given them on the Miller and Lux Ranch, however, one herd survived. This band grew in numbers until it was decided to move some of the animals to public and semi-public parks throughout the State. This was done in 1914 with the cooperation of the California Academy of Sciences. Those placed on the Del Monte property near Monterey thrived particularly well, and it is of interest to note that in recent years they have become so numerous and such pests that it became necessary to move them again. A few years ago the Del Monte herd was transferred to Owens Valley—and all was well until they began encroaching on ranches there. Once more measures to protect cultivated land have to be taken. It seems a pity that the elk, noblest of our big game animals, should be the one least fitted to co-exist with agriculture. It is a wild animal for wild country.

Harold C. Bryant contributed an article on the fur-bearing mammals of California, recounting the history of the fur trade and its importance in 1914. He points to the danger of extinction of our fur-bearers and the consequent collapse of the trade.

Among other interesting articles, is one telling of the accidental introduction of possums into California about 1910. Subsequently possums have spread throughout California and are now abundant in many regions.—*Richard S. Croker, Editor, California Fish and Game.*

RESULTS OF THE 1939 PISMO CLAM CENSUS

Every year staff members of the California State Fisheries Laboratory make a survey of the Pismo clam (*Tivela stultorum*) population at Pismo Beach. This is accomplished by digging three narrow trenches across the intertidal zone, each at an established location. Two of these are on that portion of the beach open to digging and the other is in the area where digging is prohibited. All the clams found in the trenches are carefully measured and their ages determined. The condition of the population from year to year is deduced from the data thus obtained.

This year's census was taken December 9-11, 1939. The total number of clams found, 318, was the smallest by far since 1934. Of this total, somewhat more than half were over three years old and are regarded as spawning clams. (Actually, a fair proportion of younger clams do spawn.) In numbers there were, excepting 1933, more adult

clams on the open beach than at any time since 1924, while the number in the closed area was substantially higher than it was in 1938. The great majority of these older clams were survivors of the large 1935 set.

The number of young clams was very low. There was a negligible set in 1938 and that for 1939 proved little better. Meanwhile the big 1937 set suffered an unusually high mortality with the result that two-year-old clams are relatively scarce. A fair number of three-year-olds were found—they and the four-year-olds together accounted for about two-thirds of the total.

In brief, then, the number of adult clams is greater than it has been for several years. At the same time the total population is low because of the bad sets in 1938 and 1939, and because of the poor survival of the 1937 set. This in turn means that but small additions to the spawning population can be expected in the next few years. Thus, to insure an adequate reserve of adults for those years the older clams on the beach must be given all possible protection.—*Phil M. Roedel, California State Fisheries Laboratory, Division of Fish and Game, January, 1940.*

A SPINY LOBSTER (*PANULIRUS INTERRUPTUS*) RECOVERED IN MONTEREY BAY

A spiny lobster was taken in 25 fathoms of water off Moss Landing, Monterey Bay, on the night of January 4, 1940, by Captain E. Aiello and crew of the purse seine boat *American Rose*. The boat crew had completed a purse seine haul for sardines and found the lobster in their net. The lobster, still alive, was taken to the Monterey office of the Division of Fish and Game the following morning. The specimen was a male, weighing 17½ ounces and measuring 10½ inches from tip of tail to tip of head, exclusive of the antennae or "feelers."

The spiny lobster is of considerable importance in southern California but it has not established itself north of Point Conception, the colder water to the north most likely acting as a barrier. Only an occasional lobster is reported by fishermen at Avila, some 40 miles north of Point Conception.

Because many people were of the opinion that the lobster would, if introduced, thrive in Monterey Bay, in 1913 a hundred spiny lobsters from southern California were planted in the southern portion of Monterey Bay, by the Fish and Game Commission. If this planting had proved successful, additional plants were planned. However, the last heard of this planting and of lobsters in Monterey Bay, until the present find by the crew of the *American Rose*, was in 1915. At that time, N. B. Scofield reported (California Fish and Game, vol. 1, no. 4, 1915) that a 13½-inch lobster had been found by a fisherman in a trammel net set in 16 fathoms of water, off Seaside, near Monterey. Scofield stated that the probable reason that the lobster had not established itself north of Point Conception was because the water temperature north of there was too cold for the young or larval stages.

The present find can either be attributed to the 1913 planting or to straggler wanderings from the southward during a prolonged period of warm water. Inasmuch as the natural habitat of the lobster is along rocky shores, virtually the whole coast from Point Conception to Monterey would furnish ideal retreats if water temperatures would become

favorable.—*J. B. Phillips, California State Fisheries Laboratory, Division of Fish and Game, January, 1940.*

A TRUE SMELT FOUND NEAR LOS ANGELES HARBOR

About February 17, 1940, a fisherman operating near Los Angeles Harbor caught a true smelt in his lampara net and delivered it to a San Pedro wholesale fish market. The smelt, given to the California State Fisheries Laboratory on February 19, 1940, has been identified as *Allosmerus attenuatus* Lockington. This is a common species among the whitebait of the San Francisco markets and has been recorded from San Francisco northward to central Oregon. The capture of the present specimen, which measured 116 mm. standard length, apparently constitutes a new southern record for this species and for any member of the Osmeridae found along the North American shore of the Pacific.

This fish may have strayed from more northern waters or it may have been introduced into the southern California area by tuna fishermen. Several live-bait boats fished for albacore off Oregon last summer and returned to their home port, San Pedro, during the fall of 1939. At least one of these boats released approximately 200 scoops of bait near San Pedro. The bait, taken off Washington, consisted mostly of anchovies but also comprised some smelt and young salmon. Similar situations have occurred when tuna boats returning from Mexican waters have liberated bait off southern California. Following such releases, exotic southern fishes have been caught by lampara fishermen operating near Los Angeles Harbor. (*See California Fish and Game, vol. 18, pp. 61-62.*)—*Frances N. Clark, California State Fisheries Laboratory, February, 1940.*

REVIEWS

North Pacific Fisheries, with Special Reference to Alaska Salmon

By Homer E. Gregory and Kathleen Barnes. San Francisco, New York, Honolulu, American Council of Institute of Pacific Relations, 1939. 322 pp. \$3.00.

The authors of "North Pacific Fisheries" have overlooked nothing in presenting this dispassionate account of the fisheries of Alaska, British Columbia and the Pacific coastal states. It is a virtually complete description of the fishing industry in that region. The publication of this book by the American Council of the Institute of Pacific Relations is most timely in view of the publicized threats of foreign interests to invade the salmon and halibut fisheries.

The book is primarily an economic study of the salmon industry, the greatest fishery of North America. Every angle of the industry is discussed—the physical setting of the fishery, conservation, the relative success of large and small packing companies, marketing, prices, profits, labor, and the importance of the fishery in the economy of Alaska. Throughout, sound conservation practice is stressed. A discussion of the halibut fishery and its object lesson of successful international regulation is also presented.

The description of the economic aspects of the salmon fishery is a veritable storehouse of carefully gathered and analyzed information. The ramifications of financial organization, labor problems, marketing factors, changing abundance of fish, transportation, fishermen's incomes, are all explored in a thorough manner. This study will serve as a textbook in its field for years to come and can well be a model for further studies in other industries.

The section on the international aspects of the North Pacific fisheries is particularly good, giving a brief and fairly unbiased account of the role Japan plays in the fisheries of the Pacific and the complications likely to result from Japanese expansion toward our waters. It is apparent that if great maritime powers such as the United States and Great Britain had not always insisted on the three-mile limit when exploiting fisheries near other countries, there would be a better chance of keeping alien interests away from our own fisheries.

Carl L. Alsberg, Director of the Giannini Foundation of Agricultural Economics, University of California, and research chairman of the American Council, Institute of Pacific Relations, has written an inspired foreword to the book, in which the international aspects of fisheries conservation problems on the Pacific Coast are discussed in a forthright manner.

Numerous tables and graphs serve to illustrate the text. There is an index, but no bibliography as references are given throughout in footnotes.

"North Pacific Fisheries" is recommended to all fisheries administrators and students.—*Richard S. Croker, Editor, California Fish and Game.*

Veiled Horizons; Stories of Big Game Fish of the Sea

By Ralph Bandini. New York, Derrydale Press, 1939. 222 pp., illus. \$10.00.

Again it is a pleasure to review a book written by a friend. In "Veiled Horizons," Ralph Bandini brings back memories of days at sea in quest of fish. It is a book for fishermen—but not all fishermen. Those who fish only to catch trophies not only miss the best in fishing, they will miss the beauty of "Veiled Horizons."

This is not one of the many books telling how to catch big game fish; not one of the many merely recounting battles to bring in large fish. It is more than that—the reader can pick up many angling tips in the stories of fish hooked and either lost or gaffed—but each story goes further than that. The lure of the sea to the seaman, the thrill of the chase to the sportsman are portrayed as only a real seaman and true sportsman, as well as a gifted writer can portray them. There is something indefinable that sets fishing apart from all other pursuits, and further there is something that sets a few fishing books apart from the run-of-the-mill variety. "Fishing Memories" has it, "Veiled Horizons" has it, few others written this side of England have it.

The author begins his memories with the story of his last fish—the one that he caught but only after it had licked him. From then on it is a rambling story of days at sea in quest of fish, mostly in southern California waters. Verbatim extracts at random from his log add real interest and an insight into the fisherman's mind.

Perhaps reading the book will make better sportsmen of us all. In the words of Bandini, "Now, I wonder. Is it the fishing that counts, the catching of fish, the fighting of them? Or, is it something else that makes the game? What do you think?"—*Richard S. Croker, Editor, California Fish and Game.*

In Memoriam

CAPTAIN WILLIAM LIPPINCOTT

To many of us who have known and associated with Captain William Lippincott, it was a great shock to learn of his sudden death due to heart trouble on December 22, 1939, at San Francisco. He was a friend to all and his passing leaves a gap in the ranks of the Bureau of Patrol of the Division of Fish and Game.

Captain Lippincott was born October 25, 1878, at Burney, Shasta County. He entered the service of the Division on August 1, 1918, assigned to Yreka, Siskiyou County, as a warden. On April 5, 1926, he was promoted to the position of captain, in charge of Siskiyou, Modoc, Trinity and Shasta counties. He was transferred to a similar capacity at Eureka in January, 1929, and then to San Rafael on January 27, 1932. In September, 1935, he was placed in charge of the southern division of the coast district for the Bureau of Patrol, with headquarters in San Francisco. He was in line for further promotion as he had successfully passed the State Civil Service examination for a position as assistant chief (inspector).

To Mrs. Lippincott and the family, the many friends and co-workers of Captain Lippincott wish to express their regret and sincere sympathies.—*E. L. Macaulay, Chief, Bureau of Patrol and Law Enforcement, California Division of Fish and Game.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1939, to December 31, 1939, of the Ninety-first Fiscal Year

Revenue for Fish and Game Preservation Fund:

License Revenue—

1940 Series:

Angling.....	\$139 00
Fish importers.....	5 00
Fishing party boat permits.....	7 00
Fish breeders.....	155 00
Game breeders.....	47 50

Total, 1940 series..... \$353 50

1939 Series:

Angling.....	\$379,103 50
Commercial hunting club.....	850 00
Commercial hunting club operator.....	320 00
Deer tags.....	130,400 00
Fish breeders.....	15 00
Fish importers.....	10 00
Fish packers and wholesale shell fish dealers.....	970 00
Fishing party boat permits.....	193 00
Fish tags.....	1,850 02
Game breeders.....	162 50
Game tags.....	465 54
Hunting.....	373,749 50
Market fisherman.....	30,180 00
Trapping.....	1,166 00

Total, 1939 series..... \$928,855 06

1938 Series:

Angling.....	\$7,851 51
Deer tags.....	2,853 00
Hunting.....	17,796 00
Market fisherman.....	2,400 00
Trapping.....	145 00

Total, 1938 series..... \$30,848 51

1937 Series:

Angling.....	\$115,265 03
Commercial hunting club.....	50 00
Commercial hunting club operator.....	10 00
Deer tags.....	11,437 00
Fish breeders.....	15 00
Game breeders.....	5 00
Hunting.....	43,811 47
Market fisherman.....	180 00
Trapping.....	341 00

Total, 1937 series..... \$171,114 50

1932, hunting.....	\$87 35
1928, angling.....	645 68
1928, deer tags.....	10 00
1928, hunting.....	2,971 00

Total, 1932 and 1928 series..... \$3,714 03

Total licenses, 91st fiscal year..... \$1,134,885 60

Other revenue:

Court fines.....	\$28,459 04
Deer meat permits.....	438 00
Fish packers.....	170,448 13
Kelp tax.....	204 20
Lease of kelp beds.....	52 80
Miscellaneous revenue.....	4,414 78
Publication sales.....	259 71
Salmon packers tax.....	13,407 38

Total other revenue..... \$226,684 02

Leases game refuges..... 261 63

STATEMENT OF REVENUE—Continued

For the Period July 1, 1939, to December 31, 1939, of the Ninety-first Fiscal Year

Prior year (90th fiscal year)—

1938 Series:

Angling.....	—\$6 00
Fish packers and wholesale shell fish dealers.....	35 00
Fish importers.....	—5 00
Hunting.....	35 50
Trapping.....	—2 00

Total, 90th prior year, 1938 series..... \$57 50

1937 Series:

Hunting.....	—\$35 00
Trapping.....	1 00
Fish packers and wholesale shell fish dealers.....	—30 00

Total, 90th prior year, 1937 series..... —\$64 00

Prior year (89th fiscal year)—

1938 Series:

Angling.....	\$120 00
Fish importers.....	5 00
Fish packers and wholesale shellfish dealers.....	—5 00
Fish tags.....	—1,767 24
Game tags.....	—161 34
Hunting.....	—36 00
Market fisherman.....	420 00

Total, 89th prior year, 1938 series..... —\$1,424 58

1937 Series:

Angling.....	—\$141 00
Deer tags.....	—3 00
Fish tags.....	1,767 24
Game tags.....	161 34
Hunting.....	1 00
Market fisherman.....	—420 00
Trapping.....	—2 00

Total, 89th prior year, 1937 series..... \$1,363 58

Grand total—All years, Fish and Game Preservation Fund..... \$1,361,763 75

STATEMENT OF EXPENDITURES

For the Period July 1, 1939, to December 31, 1939, of the Ninety-first Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Cashier.....	\$960 00				\$960 00
Executive.....	2,499 96	\$99 44	\$2,131 93	\$40 85	4,772 18
Exhibits.....			1,250 00		1,250 00
General office.....	4,040 74	2,081 65	14,198 12	74 91	20,395 42
Library.....	1,013 02	81	82 00	75 04	1,170 87
Property inspection.....	1,620 00	121 74	84 93	20 91	1,847 58
Publicity.....			1,172 37		1,172 37
Total Administration.....	\$10,133 72	\$2,303 64	\$18,919 35	\$211 71	\$31,568 42
Patrol and law enforcement:					
Cannery inspection.....	\$14,156 10	\$122 89	\$882 06		\$15,161 05
Executive.....	7,575 09	229 62	936 46	\$526 24	9,267 32
General office.....	3,025 81	381 70	200 87	114 22	3,722 60
Junior patrol.....	2,410 00	256 24	755 14		3,421 38
Land patrol.....	113,132 50	17,094 51	32,058 86	11,634 93	173,920 80
Marine patrol.....	42,328 12	10,053 07	24,343 95	7,462 66	84,787 80
M. V. Bluefin galley.....		324 13			324 13
M. V. N.B. Seofield galley.....		192 09			192 09
Pollution patrol.....	6,335 16	1,233 05	1,980 60	914 05	10,469 76
Total Patrol and Law Enforcement.....	\$188,962 69	\$30,104 02	\$61,164 84	\$20,652 10	\$300,883 65
Marine Fisheries:					
Central Valley Water Project Study.....	\$3,670 54	\$450 47	\$2,130 96	\$4 30	\$6,274 33
Executive.....	3,640 00	160 66	212 05		4,012 71
Field supervision.....	1,740 00	146 98	531 45		2,418 43
Fish cannery auditing.....			1,691 07		1,691 07
General office.....	6,256 92	487 47	425 46	3 10	7,172 95
Research and statistics.....	26,787 58	1,249 22	6,041 20	651 71	34,729 71
Total Marine Fisheries.....	\$42,095 04	\$2,503 80	\$11,041 19	\$659 17	\$56,299 20
Fish Conservation:					
Biological survey.....	\$5,949 00	\$654 16	\$740 00	\$89 08	\$7,433 14
Executive.....	3,090 00	108 76	138 13		3,936 89
Field supervision.....	2,940 00	304 47	638 89		3,883 36
Fish food unallocated.....		8,470 56	1,533 43		10,003 99
Fish planting.....	1,877 12	535 12	1,114 70		3,526 94
Fish rescue.....	5,609 13	897 73	1,590 90		8,097 76
General office.....	2,023 39	351 55	126 01		3,100 95
Pollution inspection.....	2,559 00	247 49	406 71	136 00	3,349 20
Statistical.....	1,230 00	284 27	1,040 65		2,554 92
Structural maintenance.....	2,250 00	297 07	539 79	13 73	3,400 59
Alpine Hatchery.....	1,052 74	459 21	124 94		1,636 89
Basin Creek Hatchery.....	2,060 33	167 47	144 25		2,372 05
Benbow Dam Experimental Station.....	1,525 92	89 60	105 16	4 88	1,725 56
Big Creek Hatchery.....	955 00	243 53	104 56	9 44	1,312 53
Blue Lakes Egg Col. Station.....	408 40	7 63	27 36		443 39
Bogus Creek Egg Col. Station.....	375 00	5 46	8 50		388 96
Brookdale Hatchery.....	1,557 82	235 24	129 80		1,922 86
Burney Creek Hatchery.....	2,956 77	201 89	140 71	6 15	3,305 52
Central Valleys Hatchery.....	1,630 00	540 38	783 35	19 89	2,973 62
Cold Creek Hatchery.....			10 00		10 00
Copco Egg Col. Station.....		30 48	85 64	9 84	125 96
Cottonwood Lakes Egg Col. Station.....			4 00		4 00
Experimental Hatchery.....	936 45	87 70	24 04		1,048 19
Fall Creek Hatchery.....	3,440 40	484 10	152 75	41 74	4,119 08
Feather River Hatchery.....	2,731 13	624 87	316 26		3,672 26
Fern Creek Hatchery.....	931 46	174 29	182 04		1,287 79
Forest Home Hatchery.....	2,391 61	1,777 81	421 99		4,591 41
Fort Seward Hatchery.....	1,678 34	241 29	18 64	8 68	1,946 95
Heenan Lake Egg Col. Station.....		53 44	1 21	30 08	84 73
Hot Creek Hatchery.....	2,400 93	2,051 02	384 90	189 63	5,026 48
Huntington Lake Hatchery.....	1,466 78	551 16	317 70		2,335 63
June Lake Egg Col. Station.....			16 30		16 30
Kaweah Hatchery.....	2,196 61	468 07	536 40	12 98	3,214 06
King Salmon Experimental Station.....			7 68		7 68
Kings River Hatchery.....	1,912 24	573 16	144 21		2,629 61
Kirman Lake Egg Col. Station.....	283 75	5 01			288 76
Klamathon Egg Col. Station.....	1,497 13	125 82	50 57	90 13	1,763 65

STATEMENT OF EXPENDITURES

For the Period July 1, 1939, to December 31, 1939, of the Ninety-first Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish Conservation—Continued					
Lake Almanor Hatchery.....	\$3,063 87	\$654 76	\$171 28		\$3,889 91
Lake Eleanor Egg Col. Station.....		18 60			18 60
Little River Egg Col. Station.....	240 00	19 32	12 60		271 92
Little Walker Lake Egg Col. Station.....	252 27	1 61			253 88
Lytlo Creek Hatchery.....			21 53		21 53
Mad River Egg Col. Station.....	200 00	42 72	11 00		253 72
Madera Hatchery.....	408 07	230 51	272 72		911 30
Marlette Lake Egg Col. Station.....	360 00	89			360 89
Mt. Shasta Hatchery.....	20,475 01	5,676 65	1,229 22	\$168 27	27,549 15
Mt. Tallac Hatchery.....	1,582 68	1,212 19	151 02		2,945 89
Mt. Whitney Hatchery.....	6,720 09	1,429 50	1,429 38	312 05	9,891 02
Mountain Home Hatchery.....	2,640 00	1,289 33	557 57		4,486 90
Prairie Creek Hatchery.....	3,179 65	655 64	300 33	8 22	4,143 84
Rush Creek Egg Col. Station.....	640 00	4 04	18 48		662 52
Scott Creek Egg Col. Station.....	870 00	38 29	34 99	3 10	946 38
Shasta River Egg Col. Station.....	540 20	28 19			568 39
Snow Mountain Egg Col. Station.....	280 00	21 21	2 50		303 71
Tahoe Hatchery.....	3,215 17	782 87	261 75		4,259 79
Waddell Creek Station.....	420 00	27 70	19 30	2 73	469 73
Yosemite Hatchery.....	2,240 65	500 28	140 70		2,881 63
Yuba River Hatchery.....	1,919 19	214 57	104 49	6 74	2,244 99
Total Fish Conservation.....	\$112,364 29	\$34,198 67	\$17,151 93	\$1,163 36	\$164,878 25
Hydraulics:					
Engineering.....	\$4,144 85	\$527 83	\$1,175 86	\$3 19	\$5,851 73
General office.....	755 00	28 99	109 28	98 72	991 99
Executive.....	2,160 00	147 02	360 17		2,667 19
Total Hydraulics.....	\$7,059 85	\$703 84	\$1,645 31	\$101 91	\$9,510 91
Game Conservation:					
Deer Damage Control.....	\$281 86	\$119 15	\$181 84		\$582 85
Duck rescue.....	739 82	274 57	644 26	\$337 10	1,995 75
Elk refuge.....	900 00	189 80	197 94		1,287 74
Executive.....	4,406 01	472 08	842 39	459 77	6,180 85
Game management.....	4,059 68	628 57	687 11	698 50	6,073 86
General office.....	1,620 00	81 19	8 18	36 96	1,746 33
Grey Lodge Refuge.....	2,400 00	201 37	26 72	1,099 56	3,787 65
Imperial Refuge.....	1,032 11	120 01	54 17	123 05	1,329 34
Los Banos Refuge.....	2,381 61	314 20	289 09	569 55	3,554 45
Predatory animal lion hunters.....	3,125 00	376 17	3,125 33	1,406 05	8,032 55
Predatory animal trapping.....	14,193 70	2,992 91	2,476 07	30 90	19,694 48
Refuge posting.....		345 57			345 57
Research.....	3,350 34	928 09	1,341 02	1,295 92	6,915 37
Statistics.....	1,200 00	85 80	645 22		1,931 02
Suisun Refuge.....	1,746 05	251 70	131 32	24 02	2,153 09
Winter feed and salt of game.....		95 80			95 80
Total Game Conservation.....	\$41,496 78	\$7,476 98	\$10,051 56	\$6,081 38	\$65,708 70
Game Farms:					
Executive.....	\$1,740 00	\$52 84	\$178 02		\$1,970 86
Game bird distribution, Los Serranos.....		298 89	24 36		323 25
Game bird distribution, Yountville.....	3,397 11	278 90	776 20		4,450 21
General office.....	559 03				559 03
Los Serranos Boarding House.....			39 09		39 09
Los Serranos Game Farm.....	5,558 22	1,778 31	924 46	\$92 68	8,353 67
Yountville Boarding House.....	254 35	340 49	76 89		671 73
Yountville Game Farm.....	5,743 14	3,573 85	975 55	706 60	10,999 14
Total Game Farms.....	\$17,251 85	\$6,321 28	\$2,994 57	\$799 28	\$27,366 98
Licenses:					
Executive.....	\$1,830 00	\$100 40	\$174 58		\$2,104 98
General office.....	450 00	82 60	53 42	\$57 32	643 34
License distribution.....	6,413 23	8,520 77	42,223 05		57,160 05
Total Licenses.....	\$8,693 23	\$8,712 77	\$42,451 05	\$57 32	\$59,914 37

STATEMENT OF EXPENDITURES

For the Period July 1, 1939, to December 31, 1939, of the Ninety-first Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Other Current Expenses:					
Maintenance and Construction of Fish Screens and Other Stream Improvements:					
Fish screens, all objects.....					\$19,518 40
Stream improvements:					
American Lake check dam.....		\$84 72			\$84 72
American River Improvement Project.....		18 80			18 80
Granlees Dam Fishway Project.....	\$1,173 32	1,076 41	\$114 85	\$2 46	2,367 04
Stream improvement overhead.....		17 10	10 50	116 26	143 86
Removal of riffles on Lower Eel River.....			96 00		96 00
Sheep Camp Lake Project.....			20 00		20 00
Total Other Current Expenses.....					\$22,248 82
Special Item:					
Appropriation to pay claim of Department Accounting Officer, Department of Finance, 91st fiscal year, Chap. 1046-39.....					\$393 61
Total Operating Expenditures, 91st fiscal Year.....					\$738,770 91
Contributions to Employees' Retirement System.....					13,596 74
Expenditures for Additions and Betterments:					
Purchase of game refuges and public shooting grounds, and construction, improvements and equipment—improvements.....	\$1,405 69	\$1,139 62	\$250 15	\$1,093 17	\$3,888 63
Total, 91st Fiscal Year.....					\$750,256 28
Prior Bienniums:					
90th fiscal year for support not closed.....					\$3,905 85
89th fiscal year for support not closed.....					—517 20
88th fiscal year for support not closed.....					1 13
Totals for 88th, 89th and 90th fiscal years not closed.....					\$3,389 78
Additions and Betterments:					
Purchase of game refuges and public shooting grounds and construction improvement and equipment, 90th fiscal year.....					\$125,000 00
Total Prior Biennium.....					\$128,389 78
Grand total Fish and Game Preserva- tion Fund.....					\$884,646 06

GAME CASES

October, November and December, 1939

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer: Failure to tag, possession spike buck, doe, spotlighting, possession closed season, no license, possession fawn, allowing dogs to run deer, venison in possession, selling, illegal marking and tagging, night, overlimit, failure to retain deer hides.....	159	\$5,045 50	2,121
Doves: No license, overlimit, closed season, shooting from automobile, before 7 a.m.....	24	675 00	-----
Ducks: Possession closed season, before 7 a.m., sale, taking eggs, overlimit, shooting from automobile, power boat, no duck stamp.....	127	2,252 50	420½
Firearms: Possession in refuge, discharge in refuge.....	56	900 00	-----
False statement to obtain license.....	1	25 00	-----
Geese: Overlimit, possession closed season, before 7 a.m., driving geese with automobile.....	21	535 00	-----
Heron: Taking.....	1	25 00	-----
Hunting: No license, closed season, night, failure to show license, closed area.....	62	1,045 00	190
Non-game bird: Possession.....	11	125 00	-----
Pheasants: Overlimit, closed season, female, shooting from automobile, no license.....	58	1,090 00	205
Pigeons: Closed season, no license.....	4	50 00	-----
Quail: Closed season, no license, closed area.....	17	435 00	-----
Rabbits: Possession cottontails, brush, closed season, no license.....	12	100 00	10
Sagehen: Closed season.....	4	100 00	-----
Protected shore birds: Shooting.....	29	535 00	3
Shooting: Early, from highway, from power boat.....	39	949 00	-----
Shotgun: Holding more than 6 shells.....	1	10 00	-----
Squirrel: Possession.....	3	40 00	25
Stealing traps.....	1	10 00	-----
Transfer license.....	2	20 00	-----
Totals.....	632	\$15,767 00	2,983½

FISH CASES

October, November and December, 1939

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalone: Possession, undersized, red, green, black, out of shell, overlimit, closed season, no license.....	12	\$165 00	7
Angling: No license, closed stream, failing to show license, false statement to obtain license, refuge, closed season, at spillway of dam, other than with hook and line, night.....	68	915 00	10
Bass: Possession black, calico, striped, white sea, undersized, overlimit, closed season, night, buying or selling, no license, other than with hook and line.....	121	1,850 00	12½
Clams: Undersized, overlimit, closed season, selling, Pismo, in clam preserve.....	22	355 00	175
Commercial fishing: No license, no boat numbers, no records.....	32	580 00	-----
Crabs: Possession undersized, female, closed season.....	2	150 00	-----
Lobsters: Closed season, undersized, overlimit.....	26	550 00	62½
Nets: Operate in closed waters, purse seine, closed waters.....	36	1,175 00	525
Pollution.....	11	1,820 00	-----
Reduction plant: No license, wastage.....	2	200 00	-----
Salmon: Overlimit, undersized, closed waters, night, closed season, other than by angling, selling untagged.....	37	920 00	47½
Spear: Within 300 ft. of stream.....	30	645 00	30
Transfer license.....	3	135 00	-----
Set lines.....	2	25 00	25
Trout: Overlimit, taking during closed season, no license, closed area, undersized golden, selling, prohibited gear, other than with hook and line held in hand.....	5	115 00	10
Operating salmon fence in Stanislaus River.....	3	200 00	50
Postdating a license.....	1	100 00	-----
Skipjack: Sale of underweight.....	4	200 00	-----
Tuna: Sale of underweight.....	3	150 00	-----
Totals.....	420	\$10,250 00	954½

SEIZURES OF FISH AND GAME

October, November and December, 1939

Fish:

Abalone.....	352
Barracuda.....	60
Bass, black.....	6
Bass, striped.....	77
Bass, striped, lbs.....	162
Clams, Pismo.....	470
Crabs.....	1,326
Lobsters.....	683
Lobsters, lbs.....	301 1/2
Salmon.....	15
Salmon, lbs.....	527
Sea-bass, white.....	46
Sea-bass, white, lbs.....	3,935
Sunfish, bluegill.....	3
Traps, lobster.....	9
Trout, eastern brook.....	56
Tuna:	
Skipjack, lbs.....	27,728
Yellowfin, lbs.....	11,474

Game:

Deer.....	33
Deer meat, lbs.....	745
Doves.....	148
Ducks.....	334
Geese.....	108
Hens.....	1
Muskrat hides.....	38
Pheasants.....	53
Pigeons.....	10
Quail.....	44
Rabbits.....	10
Robins.....	4
Sea-gull.....	1
Shore birds.....	53
Squirrels.....	1
Teal, blue wing.....	4

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

October, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Oregon and Washington waters		Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	Region 70, Los Angeles	Region 80, San Diego	
Anchovy			1,200			\$28,444		829,704					829,704
Barracuda					11,407	100,283	69,539	181,289			97,244	74,006	352,539
Cabezone				27				27					27
Carp		301						301					301
Catfish		29,664						29,664					29,664
Cultus, Pacific	37,369		10,350	2,569	56	43		50,387					50,387
Flounder, Starry	19,360		136,872	169	506			156,907					156,907
Grouper												1,025	1,025
Hake	460		822					1,282					1,282
Halibut, California			5,093	786	30,999	5,495	6,231	54,604				7,407	62,011
Halibut, Northern	6,892							6,892					6,892
Kingfish			1,080	32,443		34,548	8	68,179					68,179
Mackerel, Horse				1,154		3,330		4,484					4,484
Mackerel, Pacific			95	101,682	4,453	10,003,133	622,912	10,792,275					10,792,275
Mackerel, Spanish											80		80
Perch			4,729	780	7	860		6,376					6,376
Pompano, California						1,083		1,083					1,083
Rock Bass					189	4,551	11,056	15,796				1,799	17,595
Rockfish	78,830		13,059	49,796	2,058	9,322	9,787	162,852				6,917	169,769
Sablefish	47,783		1,840	1,112		5,721		56,465					56,465
Sand Dab	12,515		70,750	6,225		301		89,851					89,851
Sardine		23,833,100	\$9,287,502	109,789,935		508,803	1,246	223,420,586					223,420,586
Sculpin					2	6,098	640	6,740					6,740
Sea-bass, Black					194	295	276	765			44,634	4,447	49,846
Sea-bass, White			6,307	10,846	66,397	\$4,627	13,215	181,392			35	24,100	205,527
Shark	2,056	315,094	842,149	52,457	4,176	6,897	2,603	725,432					725,432
Sheepshead					19	792	866	1,677				420	2,097
Skate	410		21,568	2,477	3,495	260		28,150					28,150
Smelt	5,567		7,135	10,230	141	14,923	940	38,936					38,936
Sole	272,435		443,085	46,527	10,910	255	258	773,500					773,500

Split-tail		3,935					3,935					3,935	
Swordfish, Broadbill					3,083	12,954	2,936	18,973			2,301	21,274	
Tuna, Albacore		5,209	778,763		732,838	16,197		1,533,007	502,872	12,001		2,047,880	
Tuna, Bluefin						40		40			2,456	2,525	
Tuna, Bonito					10,711	1,535,742	37,494	1,583,947			29	1,627,934	
Tuna, Skipjack						4,890	564,242	569,132			43,767	3,403,550	
Tuna, Yellowfin					37	319	199,364	199,720			674,194	2,160,224	7,297,582
Turbot		9,783	175					9,958			1,025,719	6,072,143	9,958
Whitebait	107	442						549				549	
Whitefish, Ocean						112		112			1,234	1,346	
Yellowtail						58	12,535	12,893			4,815	179,291	196,999
Miscellaneous Fish	6,461	7,618	375	327	1,029	164	16,004					16,004	
Crustacean:													
Lobster, Spiny					44,035	52,371	30,627	128,233				128,233	
Shrimp		77,437						77,437				77,437	
Mollusk:													
Abalone			56,350	6,050	38			62,438				62,438	
Clam, Cockle	2	11			1,773			1,786				1,786	
Clam, Gaper		220						220				220	
Clam, Pismo			2,709	13,772				16,481				16,481	
Clam, Soft-shell	83	5,806						5,889				5,889	
Clam, Washington	1,644	190						1,834				1,834	
Octopus	81				104			185				185	
Oyster, Eastern		12,844						12,844				12,844	
Oyster, Japanese		172,636						172,636				172,636	
Oyster, Native		110						110				110	
Squid			7,085	26,597				33,682				33,682	
Total pounds	492,055	24,182,094	90,646,041	110,954,672	952,822	13,332,418	1,587,539	242,147,641	502,872	12,001	1,849,397	8,579,110	253,091,021

* The eight geographical regions of the State are as follows:

Regions 10 and 20, Del Norte and Eureka: Del Norte, Humboldt and Mendocino counties.

Region 30, Sacramento: Sacramento and San Joaquin river systems with the delta areas, including Suisun Bay and Lake County.

Region 40, San Francisco: Sonoma, Marin, San Francisco and San Mateo counties, including San Francisco and San Pablo bays.

Region 50, Monterey: Santa Cruz and Monterey counties.

Region 60, Santa Barbara: San Luis Obispo, Santa Barbara and Ventura counties.

Region 70, Los Angeles: Los Angeles and Orange counties.

Region 80, San Diego: San Diego and Imperial counties.

These tables are subject to slight revision due to belated supplemental items.

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

November, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	
Anchovy.....			15,500			370,254		385,754			385,754
Barracuda.....					10	4,516	18,809	23,341	166,768	82,399	272,508
Cabezone.....				334				334			334
Cabrilla.....									12,118		12,118
Carp.....		293						293			293
Catfish.....		27,354						27,354			27,354
Cultus, Pacific.....	35,657		9,563	8,488	11	1,130		54,849			54,849
Flounder, Starry.....	12,915		42,189	566	1,219			56,889			56,889
Grouper.....									3,235	4,345	7,600
Hake.....	2,350		345					2,695			2,695
Halibut, California.....			4,924	1,466	56,956	5,151	875	49,372		20,392	69,764
Hardhead.....		850						850			850
Herring, Pacific.....			4,050				522	4,572			4,572
Kingfish.....				17,132	43	26,382	216	43,773			43,773
Mackerel, Horse.....				8,507		415,644		424,241			424,241
Mackerel, Pacific.....				85,278	5,974	19,300,326	557,102	20,008,680			20,008,680
Mackerel, Spanish.....									2,825		2,825
Perch.....			1,969		290	988		3,197			3,197
Pike.....		25						25			25
Pompano, California.....					958			958			958
Rock Bass.....					1,003	5,341	8,353	15,597	1,806	1,636	19,039
Rockfish.....	106,279		15,000	109,655	21,377	17,628	5,508	275,507		15,974	291,481
Sablefish.....	60,445		1,120	4,547		17,760		83,881			83,881
Salmon.....		2,581						2,581			2,581
Sand Dab.....	20,880		42,401	13,674		390		80,405			80,405
Sardine.....		22,028,110	120,977,518	97,411,521	107	39,528,529	161,602	280,107,447			280,107,447
Sculpin.....						4,259	6,103	10,362			10,362
Sea-bass, Black.....				50		528		627	29,594	17,498	48,010
Sea-bass, White.....			522	27,104	39,039	46,113	1,068	113,906	212	22,198	136,316

Shark	11,571	403,571	478,257	130,870	4,635	5,048	1,235	1,035,606			1,035,606
Sheepshead					10,020	1,570	1,707	13,297		2,681	15,978
Skate	920		16,378	1,790	3,695			22,762			22,762
Smelt	170		1,987	8,716	33	14,920	2,840	28,669			28,666
Sole	503,584		242,781	47,618	7,882	173	77	805,115			805,115
Split-tail		4,788						4,788			4,788
Swordfish, Broadbill						321		321			321
Tomcod	2,355		50					2,405			2,405
Tuna, Albacore				700	10,104	33,245	290	44,339			44,339
Tuna, Bluefin			4,095					4,095			4,095
Tuna, Bonito					8,571	118,203	11,065	137,839	19,841	52,397	210,077
Tuna, Skipjack							532,891	532,891	890,934	2,111,448	3,544,273
Tuna, Yellowfin									910,944	5,695,145	6,576,089
Turbot			5,255	525				5,780			5,780
Whitebait			82					82			82
Whitefish, Ocean					2,393	481		2,874		1,992	4,866
Yellowtail						585	123	708	20,751	370,070	391,532
Miscellaneous Fish	9,966		5,231	245	520	6,946	420	23,299			23,299
Crustacean:											
Crab											
Crab, Rock			372,600	12,220				384,820			384,820
Lobster, Spiny					39,012	63,921	34,373	137,306	1,205	7,765	140,276
Shrimp			53,810	975				54,485			54,485
Mollusk:											
Abalone				725	22,600			23,325			23,325
Clam, Cockle			10			1,274		1,290			1,290
Clam, Gaper			212					212			212
Clam, Pismo				2,468	12,768			15,226			15,226
Clam, Soft-shell	44		5,878					5,922			5,922
Clam, Washington	2,361		219					2,580			2,580
Octopus	78		24	205		214		522			522
Oyster, Eastern	35		12,167					12,202			12,202
Oyster, Japanese			102,381					102,381			102,381
Oyster, Native	10							10			10
Squid				22,015		24,250		46,265			46,265
Total pounds	781,920	22,467,672	122,470,654	97,917,154	229,347	60,077,015	1,345,179	305,294,941	2,069,556	8,375,940	315,740,437

* See footnote to table for October.

COMMERCIAL FISH LANDINGS IN CALIFORNIA BY FISHING BOATS

December, 1939

Compiled by the Division of Fish and Game, Bureau of Marine Fisheries

Species	California waters								Waters south international boundary		Total landings by fishing boats
	*Regions 10 and 20, Del Norte and Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds	Region 70, Los Angeles	Region 80, San Diego	
Anchovy.....						499,484		499,484			499,484
Barracuda.....					18,174	8,886		27,060	50,277	119,456	205,793
Cabezone.....				17	20			37			37
Cabrilla.....									10,213		10,213
Carp.....		818						818			818
Catfish.....		17,809						17,809			17,809
Codfish.....						25		19,202			19,202
Cultus, Pacific.....	8,376		6,734	4,015	52			20,506			20,506
Flounder, Starry.....	2,335	345	17,070	750					5,433		5,433
Grouper.....								380			380
Hake.....			350					53,155		11,200	64,445
Halibut, California.....			3,276	1,066	39,119	9,694		9,820			9,820
Hardhead.....		9,820						20,439			20,439
Herring, Pacific.....			14,224				6,215	22,143			22,143
Kingfish.....			770	12,765	50	8,550		38,769		75	38,769
Mackerel, Horse.....				524		38,245					
Mackerel, Pacific.....				73,171	5,153	17,123,778	1,985,887	19,187,989			19,187,989
Mackerel, Spanish.....									1,255	2,282	3,537
Perch.....			1,228	160		1,007		2,395			2,395
Pike.....		30						30			30
Pompano, California.....						330		330			330
Ratfish.....			750					750			750
Rock Bass.....					4,534	3,712	3,869	12,215	430	3,032	15,686
Rockfish.....	28,995		19,499	120,101	26,760	19,129	3,113	217,597		2,220	219,817
Sablefish.....	4,120		3,383	1,112		2,130		10,745			10,745
Salmon.....		32,245						32,245			32,245
Sand Dab.....	14,426		32,038	454		333		47,251			47,251
Sardine.....		24,306,165	126,194,120	104,509,685		53,417,132	27,568	308,754,970			308,754,970
Sculpin.....				245	44	3,727	3,752	7,479			7,479
Sea-bass, Black.....						219		508	2,042	3,297	5,347
Sea-bass, White.....			401	3,450	22,932	3,229	203	30,305	519	23,749	54,573

Shark	1,508	354,791	703,053	288,283	10,142	3,168	28	1,361,033			1,361,033
Sheepshead					9,713	1,888	734	12,335	2,522		14,857
Skate	1,420		18,117	1,059	6,008	38		27,242			27,242
Smelt	487		5,772	3,901	231	12,964	1,778	25,226	459		25,685
Sole	169,940		377,614	4,611	8,816		30	561,070			561,070
Split-tail		4,305						4,305			4,305
Swordfish, Broadbill							475	475			475
Tomcod	575		320					895			895
Tuna, Bluefin			620					620			620
Tuna, Bonito				17	444	64,685	26,556	91,702	3,165	36,037	131,807
Tuna, Skipjack							32,616	32,616	313,304	1,324,745	1,670,665
Tuna, Yellowfin									889,264	6,647,404	7,536,668
Turbot			2,580	325				2,905			2,905
Whitebait			1,944					1,944			1,944
Whitefish, Ocean					6,472	799	592	7,863	100	2,389	10,352
Yellowtail						16	7,989	8,005	20,363	172,762	201,130
Miscellaneous Fish	6,485		7,438	175	179	22,824	80	37,181	100		37,281
Crustacean:											
Crab	43,536		420,446	8,036				472,618			472,618
Crab, Rock						395		395			395
Lobster, Spiny					18,011	26,625	10,389	55,025	12,605	124,632	192,262
Shrimp			28,910	1,662				30,602			30,602
Mollusk:											
Abalone				12,575	17,050			29,625			29,625
Clam, Cockle			30			991		1,021			1,021
Clam, Gaper			198					198			198
Clam, Pismo				1,895	12,605			13,900			13,900
Clam, Soft-shell			4,017					4,017			4,017
Clam, Washington	1,820		214					2,034			2,034
Octopus	16		33	146	11	203		409			409
Oyster, Eastern			20,594					20,594			20,594
Oyster, Japanese			136,097					136,097			136,097
Oyster, Native	1,895		181					2,076			2,076
Squid				2,030				2,030			2,030
Total pounds	285,994	24,726,328	128,022,201	105,352,926	206,623	71,274,335	2,112,182	331,980,489	1,318,082	8,477,251	341,775,822

*See footnote to table for October.

SHIPMENTS OF FRESH FISH FROM OTHER STATES AND FOREIGN COUNTRIES

October, 1939

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Albacore.....	401,330		
For fresh fish markets:*			
Mollusk:			
Clam, Cockle.....		2,163	
Total pounds.....	401,330	2,163	

November, 1939

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Skipjack.....			145,140
For fresh fish markets:*			
Cabrilla.....		122	
Corbina, Mexican.....		2,798	
Sea-bass, Totuava.....		138,881	
Total pounds.....		141,801	145,140

December, 1939

	Oregon and Washington	Gulf of California	Japan
For canneries:			
Tuna, Skipjack.....			486,102
For fresh fish markets:*			
Cabrilla.....		539	
Sea-bass, Totuava.....		255,525	
Total pounds.....		256,064	486,102

* This record includes only that fish which is voluntarily reported to the Division of Fish and Game and does not represent all shipments.

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief.....	San Francisco
Clarence Elliger, Assistant Hydraulic Engineer.....	San Francisco
Byron Wittorff, Assistant.....	San Francisco
Edward Hensley, Junior Engineering Aid.....	San Francisco
Samuel Kabakov, Junior Engineering Aid.....	San Francisco
Emmert Lippincott, Junior Engineering Aid.....	San Francisco

BUREAU OF LICENSES

H. R. DUNBAR, Chief.....	Sacramento
L. O'Leary, License Agent.....	Sacramento
O. Coleman, License Agent.....	San Francisco
R. Nickerson, License Agent.....	Los Angeles

BUREAU OF PATROL

E. L. MACAULEY, Chief of Patrol.....	San Francisco
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CENTRAL DISTRICT (Headquarters, Sacramento)

LaRue Chappell, Inspector in Charge.....	Sacramento
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Northern Division

A. A. Jordan, Captain.....	Redding
Jos. H. Sanders, Captain.....	Sacramento
A. H. Willard, Captain.....	Nevada City
E. O. Wraith, Captain.....	Susanville
L. E. Mercer, Warden, Butte County.....	Chico
Taylor London, Warden, Colusa County.....	Colusa
Albert Sears, Warden, El Dorado County.....	Placerville
E. C. Vail, Warden, Glenn County.....	Willows
Don Davison, Warden, Modoc County.....	Alturas
Earl Hiscox, Warden, Nevada County.....	Nevada City
Wm. La Marr, Warden, Placer County.....	Tahoe City
Nelson Poole, Warden, Placer County.....	Auburn
E. J. Johnson, Warden, Plumas County.....	Quincy
J. E. Hughes, Warden, Sacramento County.....	Sacramento
H. S. Vary, Warden, Sacramento County.....	Sacramento
Eugene Durney, Assistant Warden, Sacramento County.....	Sacramento
Earl Caldwell, Warden, Shasta County.....	Burney
Chas. Love, Warden, Shasta County.....	Redding
Don Chipman, Warden, Siskiyou County.....	Dunsmuir
Brice Hammack, Warden, Siskiyou County.....	Yreka
Fred R. Starr, Warden, Siskiyou County.....	Dorris
R. E. Tutt, Warden, Sierra County.....	Downieville
A. Granstrom, Warden, Sutter County.....	Yuba City
R. W. Anderson, Warden, Tehama County.....	Red Bluff
C. L. Gourley, Warden, Trinity County.....	Weaverville
C. O. Fisher, Warden, Yolo County.....	Woodland
R. A. Tinnin, Warden, Yuba County.....	Browns Valley

Southern Division

S. R. Gilloon, Captain.....	Fresno
John O'Connell, Captain.....	Stockton
R. J. Little, Warden, Amador County.....	Pine Grove
L. R. Garrett, Warden, Calaveras County.....	Murphys
F. A. Bullard, Warden, Fresno County.....	Reedley
Paul Kehrler, Warden, Fresno County.....	Fresno
Lester Arnold, Warden, Kern County.....	Bakersfield
C. S. Donham, Warden, Kern County.....	Kernville
Ray Ellis, Warden, Kings County.....	Hanford
H. E. Black, Warden, Madera County.....	Madera
Gilbert T. Davis, Warden, Mariposa County.....	Mariposa
M. S. Clark, Warden, Merced County.....	Merced
R. J. Bullard, Warden, San Joaquin County.....	Tracy
Wm. Hoppe, Warden, San Joaquin County.....	Lodi
Geo. Magladry, Warden, Stanislaus County.....	Modesto
W. I. Long, Warden, Tulare County.....	Visalia
Roswell Welch, Warden, Tulare County.....	Porterville
F. F. Johnston, Warden, Tuolumne County.....	Sonora

COAST DISTRICT (Headquarters, San Francisco)

K. P. Allred, Inspector in Charge-----San Francisco

Northern Division

W. J. Harp, Captain-----Ukiah
 J. D. Dondero, Captain-----Lakeport
 Henry Lencioni, Captain-----Santa Rosa
 Ray Diamond, Warden, Del Norte County-----Crescent City
 John Hurley, Warden, Humboldt County-----Eureka
 W. F. Kaliher, Warden, Humboldt County-----Fortuna
 Scott Feland, Warden, Lake County-----Lakeport
 R. J. Yates, Warden, Marin County-----San Rafael
 Ovid Holmes, Warden, Mendocino County-----Fort Bragg
 Leo Mitchell, Warden, Mendocino County-----Point Arena
 R. Remley, Warden, Mendocino County-----Willits
 J. W. Harbuck, Warden, Napa County-----Napa
 Bert Laws, Warden, Sonoma County-----Petaluma
 Victor Von Arx, Warden, Sonoma County-----Santa Rosa

Southern Division

O. P. Brownlow, Captain-----Alameda
 C. L. Bundock, Warden, Alameda County-----Oakland
 Ed Clements, Warden, Contra Costa County-----Martinez
 Owen Mello, Warden, Monterey County-----Pacific Grove
 Orben Philbrick, Warden, Monterey County-----King City
 F. H. Post, Warden, Monterey County-----Salinas
 J. P. Vissiere, Warden, San Benito County-----Hollister
 Lee C. Shea, Warden, San Francisco County-----San Francisco
 F. W. Hecker, Warden, San Luis Obispo County-----San Luis Obispo
 C. R. Peek, Warden, San Mateo County-----San Mateo
 C. E. Holladay, Warden, Santa Clara County-----San Jose
 F. J. McDermott, Warden, Santa Cruz County-----Santa Cruz

SOUTHERN DISTRICT (Headquarters, Los Angeles)

C. S. Bauder, Inspector in Charge-----Los Angeles
 E. H. Ober, Captain, Special Duty-----Los Angeles

Western Division

Earl Macklin, Captain-----Summerland
 L. T. Ward, Captain-----Escondido
 Fred Albrecht, Warden, Los Angeles County-----Los Angeles
 Walter Emerick, Warden, Los Angeles County-----Palmdale
 Theodore Jolley, Warden, Los Angeles County-----Los Angeles
 John Spicer, Warden, Los Angeles County-----Los Angeles
 J. W. Thornburg, Warden, Los Angeles County-----Los Angeles
 W. L. Hare, Warden, Riverside County-----Hemet
 E. H. Glidden, Warden, San Diego County-----San Diego
 Walter Shannon, Warden, San Diego County-----Julian
 A. R. Ainsworth, Warden, Santa Barbara County-----Santa Maria
 R. E. Bedwell, Warden, Santa Barbara County-----Santa Barbara
 G. N. Johnson, Warden, Ventura County-----Ventura

Eastern Division

H. C. Jackson, Captain-----San Bernardino
 W. S. Talbott, Warden, Inyo County-----Bishop
 C. J. Walters, Warden, Inyo County-----Independence
 Al Crocker, Warden, Mono County-----Bridgeport
 Charles Mayfield, Warden, Orange County-----Orange
 W. C. Blewett, Warden, Riverside County-----Indio
 R. C. O'Conner, Warden, Riverside County-----Banning
 A. L. Stager, Warden, San Bernardino County-----Upland
 W. C. Malone, Warden, San Bernardino County-----San Bernardino
 James Loudagin, Warden, San Bernardino County-----Big Bear Lake

MARINE PATROL

C. H. Groat, Inspector in Charge	Terminal Island
Ralph Classic, Captain	Monterey
Lars Weseth, Master, <i>M. V. N. B. Scofield</i>	Terminal Island
Walter Engelke, Master, <i>M. V. Bluefin</i>	Terminal Island
Howard V. Shebley, Warden, Cruiser <i>Bonito</i>	Santa Barbara
John Barry, Assistant Warden, Cruiser <i>Bonito</i>	Santa Barbara
Warden, Cruiser <i>Broadbill</i>	San Diego
Kenneth Webb, Assistant Warden, Cruiser <i>Broadbill</i>	San Diego
Donald Glass, Warden, Cruiser <i>Marlin</i>	Santa Monica
Niles Millen, Assistant Warden, Cruiser <i>Marlin</i>	Santa Monica
Charles Sibeck, Warden, Launch <i>Perch</i>	Sacramento
L. M. Booth, Assistant Warden, Launch <i>Perch</i>	Sacramento
Kenneth Hooker, Warden, Cruiser <i>Quinnat III</i>	San Francisco
Richard Hardin, Assistant Warden, Cruiser <i>Quinnat III</i>	San Francisco
K. Lund, Assistant Warden, Launch <i>Sturgeon</i>	Martinez
Carmi Savage, Warden, Cruiser <i>Tuna</i>	Avalon
Phillip Westcott, Assistant Warden, Cruiser <i>Tuna</i>	Avalon
E. R. Hyde, Warden, Cruiser <i>Yellowtail</i>	Balboa
L. R. Metzgar, Assistant Warden, Cruiser <i>Yellowtail</i>	Balboa
W. J. Black, Warden	Monterey
E. A. Chan, Warden	Terminal Island
Erol Greenleaf, Warden	Terminal Island
Lester Golden, Warden	Arroyo Grande
N. C. Kunkel, Warden	Terminal Island
Leslie E. Lahr, Warden	Eureka
Ralph Miller, Warden	San Francisco
Tate F. Miller, Warden	Terminal Island
T. W. Schilling, Warden	Terminal Island
G. R. Smalley, Warden	Richmond
T. J. Smith, Warden	San Diego
L. G. Van Vorhis, Warden	Terminal Island
E. L. Walker, Warden	Terminal Island

POLLUTION DETAIL

Paul Shaw, Chemist in Charge	San Francisco
C. L. Towers, Warden	Los Angeles
Jack McKerlie, Warden	Oakland
J. A. Reutgen, Assistant Warden, Launch <i>Rainbow</i>	Stockton
R. Schoen, Warden	Terminal Island
Clarence Whaley, Assistant Warden	Long Beach
Don Hall, Assistant Warden	Santa Barbara

CALIFORNIA JUNIOR GAME PATROL

M. F. Joy, Warden, Superintendent Junior Game Patrol	San Francisco
Geo. D. Seymour, Assistant, Junior Game Patrol	San Francisco

MARINE PATROL AND RESEARCH

Motor Vessel <i>N. B. Scofield</i> , Terminal Island
Motor Vessel <i>Bluefin</i> , Terminal Island
Cruiser <i>Yellowtail</i> , Newport Harbor
Cruiser <i>Broadbill</i> , Santa Monica
Cruiser <i>Quinnat III</i> , San Francisco
Cruiser <i>Bonito</i> , Santa Barbara
Cruiser <i>Marlin</i> , San Diego
Cruiser <i>Tuna</i> , Avalon
Launch <i>Rainbow</i> , Stockton
Launch <i>Shrapnel</i> , Lakeport
Launch <i>Sturgeon</i> , Martinez
Launch <i>Perch</i> , Sacramento

